INSTRUCTION MANUAL

FOR THE

SWEEP SIGNAL GENERATOR

TYPE 240-A

BOONTON RADIO CORPORATION
BOONTON, NEW JERSEY
U. S. A.

4-55

Printed in U.S.A.

INSTRUCTION MANUAL

FOR THE

SWEEP SIGNAL GENERATOR

TYPE 240-A

BOONTON RADIO CORPORATION
BOONTON, NEW JERSEY
U. S. A.

Printed in U.S.A.

TABLE OF CONTENTS

Section		Page
I.	**DESCRIPTION**	
	A. General Description	5
	B. Power Sources	5
II.	**OPERATING INSTRUCTIONS**	
	A. General	6
	B. Panel Layouts and Controls	6
	C. Operational Checks	7
	D. Measuring-Circuit Connections	8
III.	**SPECIFICATIONS**	
	A. CW Signal Generator	
	1. Frequency Range	9
	2. Frequency Accuracy	9
	3. Frequency Calibration	9
	4. RF Output Voltage Range	9
	5. RF Output Voltage Accuracy	9
	6. RF Output Impedance	9
	7. Amplitude Modulation	9
	B. Swept Frequency RF Signal Generator	
	1. Frequency Range	9
	2. Center Frequency Accuracy	9
	3. RF Output Voltage Range	9
	4. RF Output Voltage Accuracy	9
	5. RF Output Voltage Flatness	9
	6. RF Output Impedance	9
	7. Sweep Width Range	9
	8. Sweep Repetition Rate	9
	9. External Source of Sweep Voltage	9
	10. Linearity of Swept RF	9
	11. Blanking of Swept RF Output	9
	12. Low Frequency Sweep Voltage Output	9
	C. Crystal Markers	9
	1. Marker Spacing	9
	2. Reference Frequency Accuracy	9
	3. Amplitude Control	9
	D. Pip Markers	9
	1. Shape	9
	2. Amplitude and Position Control	9
	E. Composite Signal Adder	9
	1. Gain	9
	2. Test input Voltage Range	9
	F. General	9
	1. Power Requirement	9
	2. Dimensions	9
	3. Weight	9
	4. Tube Complement	9
	5. Accessories	9

TABLE OF CONTENTS—Continued

Section — Page

IV. PRINCIPLES OF OPERATION

A. Block Diagram

1. Precision CW Signal Generator ---- 10
2. Sweep Signal Generator ---- 10
3. Crystal-Controlled Reference Frequencies and Adder Stage 11
4. Pip Marker Generator ---- 11
5. Power Supply ---- 11

B. Schematic Circuit Diagram ---- 11

1. RF Oscillator and Reactors ---- 11
2. Broad-Band Output Amplifier ---- 12
3. Amplitude Modulator ---- 12
4. Output Attenuator System ---- 12
5. Sweep Voltage Generator ---- 13
6. Automatic Flatness Control ---- 13
7. RF Blanking ---- 13
8. Crystal Marker Generator ---- 14
9. Pip Marker Generator ---- 14
10. Composite Signal Adder ---- 14
11. Power Supply ---- 15

V. MAINTENANCE

A. General ---- 15
B. Removing the Instrument from Its Cabinet ---- 18
C. Replacement of Tubes ---- 18
D. Power Supply Check ----
E. Trouble Shooting ---- 20
F. Voltage Chart ---- 22

VI. TABULAR LIST OF PARTS

A. Pip Chassis ---- 24
B. Birdie Chassis ---- 25
C. Audio Oscillator ---- 27
D. RF Unit ---- 28
E. Sweep Chassis ---- 30
F. Power Supply ---- 32

VII. CIRCUIT SCHEMATIC DIAGRAM ---- 35

LIST OF ILLUSTRATIONS

Figure	Title	Page
II- 1	Front Panel Control Layout (Photo)	6
II- 2	Use of Output Cable Type 501-B	8
II- 3	Use of Attenuator Type 509-B	8
IV- 1	Block Diagram of Complete System	10
IV- 2	RF Oscillator, Basic Circuit	11
IV- 3	Output Amplifier and AM Modulator, Basic Circuit	12
IV- 4	Output System, Basic Circuit	12
IV- 5	Output Characteristics	12
IV- 6	Sweep Control Waveforms	13
IV- 7	Flatness Control, Basic Circuit	13
IV- 8	Blanking, Basic Circuit	13
IV- 9	Crystal Markers, Basic Circuit	14
IV-10	Pip Markers, Basic Circuit	14
IV-11	Adder, Basic Circuit	15
IV-12	Power Supply, Basic Circuit	15
V- 1	Identification of Major Sub-Assemblies (Photo)	16
V- 2	Rear and Front View of Power Supply (Photo)	17
V- 3	Audio Oscillator Chassis (Photo)	17
V- 4	Sweep Generator Chassis (Photo)	18
V- 5	Pip Marker Generator Chassis (Photo)	19
V- 6	Birdie Marker Generator and Adder Chassis (Photo)	19
V- 7	RF Unit Terminal Board (Photo)	23

SECTION I
DESCRIPTION

A. GENERAL DESCRIPTION

1. FUNCTIONS

The Sweep Signal Generator Type 240-A has been designed for use in the development and testing of radio frequency pass-band amplifiers over the frequency range of 4.5 to 120 mc. It consists of (1) a precision CW Signal Generator which may be amplitude modulated, (2) a Swept Frequency Generator providing linear frequency deviation over the range from $\pm 1\%$ of the center frequency to $\pm 30\%$ of the center frequency or 15 mc whichever is smaller, and (3) a Marker System producing (a) crystal-referenced birdie-type markers, (b) adjustable pip interpolation markers, and (c) a composite signal containing the markers added to the response of the system under test. The precision output attenuator system operates on both cw and swept outputs. Provisions are included for sweeping from an external source of sweeping voltages and for providing to an oscilloscope the synchronized sweep voltage.

2. DESIGN

The instrument is contained in a single cabinet and consists of the following major sub-assemblies:

a. Front Panel
b. RF Head
c. Audio Oscillator
d. Pip Marker Generator
e. Marker Frequency Generator and Adder Stage
f. Sweep Chassis
g. Power Supply

The various sub-assemblies are mounted in an aluminum framework to which are attached the carrying handles. A dust cover slides over the completed assembly.

The RF Unit is fully shielded and is secured to the Front Panel which contains all the controls and connections into and out of the generator except the power cable. The Power Supply is carried on a formed steel chassis which is secured to the rear end of the frame assembly. All connections to the power supply are by way of plugs and sockets.

The balance of the circuitry is contained on etched and dip soldered panels which are bolted into the framework. The Audio Oscillator chassis, used to generate the 1000 cps tone required for amplitude modulation, is carried on the framework above and to the right of the RF Unit, looking from the front of the panel.

The Sweep Chassis, used for generating the sweep voltages required to drive the reactor units in the RF head, is a large panel carried horizontally below the RF Unit near the bottom of the assembly. All Sweep Chassis tubes and controls are accessible from the bottom of the instrument after the seperate bottom plate has been removed.

The Marker and Adder Stage Assembly is a separate aluminum frame bolted to the front panel by the control bushings and consists of the Crystal and Pip Marker Generator Chassis with their associated selector switch assembly and the adder stage.

3. FEATURES

For reasons of simplicity in manufacture and maintenance, associated types of circuitry are grouped on separate panels within the instrument. On the Front Panel, all controls associated with a given function are grouped, with those controls most frequently used given preferred locations. A new style meter and an innovation in the method of indicating the active range on the frequency dial provide unusually good readability of the output functions of the generator. All cable connections in and out of the instrument are located along the bottom of the Front Panel to keep the cables next to the work bench.

Folding handles are mounted directly in the framework for carrying the instrument. The dust cover, which covers the top, sides and rear, slides off from the top leaving all components in the instrument, except those inside of the RF can, exposed for servicing. The bottom plate comes off independently of the dust cover. Ventilation holes are located for optimum circulation throughout the instrument.

The instrument is supplied complete with tubes, instruction book and RF Output Cable Type 501-B.

B. POWER SOURCES

The power for all units in the instrument is provided by the Power Supply chassis which contains electronic regulator systems and reference tubes for supplying the voltages required.

A time delay relay controls the high voltage rectifier system so that high voltage will not be applied to critical portions of the circuit until the tube elements have come up to operating temperature. Therefore, there is approximately 30 seconds time lag between throwing the power switch and initial application of the B+ voltage to the critical circuits in the instrument.

Some critical filament voltages are regulated by a line regulating transformer having independent input and output windings. Since the performance of the regulater is based on a rated power line frequency, the line voltage and frequency rating shown on the plate above the line cord on the rear of the cabinet must be observed.

The instrument is available for use on the following power line sources only:

1. Type 240-A: 105-125 volts, 60 cps.
2. Type 240-AP: 105-125 volts, 50 cps.
   Note: For use on 220 volts, an external transformer must be used to drop the line voltage to the range of 105-125 volts.

Power consumption for either model is approximately 280 watts.

SECTION II
OPERATING INSTRUCTIONS

A. GENERAL

1. After removing the instrument from the packing carton, plug the power cord into a source of voltage corresponding to that shown on the voltage plate located immediately above the power cord outlet on the rear of the dust cover. NOTE: Use of a power source other than that specified on the plate will result in damage to the instrument.

2. Turn the "RF LEVEL VERNIER" knob off (counter-clockwise) as far as it will go. This protects the meter during warm-up. Turn the POWER SWITCH, located at the lower center of the front panel, to the ON position.

3. Attach the RF Output Cable Type 501-B to the front panel RF OUTPUT jack.

B. PANEL LAYOUT AND CONTROLS

The front view of the Sweep Signal Generator Type 240-A, Figure II-1, shows the various controls, meters and measuring circuit connections. Controls are grouped according to function as indicated by the brackets on the figure. The RF Output and Frequency indicators are grouped in a "T" across the top and down the center of the instrument. The four controls associated with operation as a sweep generator are grouped on the right side and the controls for the two Marker Systems are grouped on the left. Power controls and indicators are centrally located near the bottom of the instrument. All connections into and out of the generator are grouped along the bottom of the cabinet, inputs being grouped on the left, outputs on the right.

1. FREQUENCY

The five-band frequency dial, visible in the upper right hand window, indicates the frequency of the output signal in megacycles. The red circle lying on the fiducial line indicates the active range. The total range of 4.5-120 mc is covered in five ranges of 4.5-9, 9-18, 18-35, 35-75 and 75-120 mc. The dial-type FREQUENCY RANGE knob indicates the operating range. The CENTER FREQUENCY control knob drives a variable air capacitor in the RF Unit through a friction drive.

2. RF OUTPUT

The RF LEVEL meter at the upper left hand corner of the panel contains two scales, one red and one black, which are associated with the corresponding colors on the RF LEVEL FULL SCALE control. The output voltage level is determined by applying the output level value indicated on the dial of the RF LEVEL FULL SCALE knob to the corresponding full scale reading on the meter which is adjusted by the RF LEVEL VERNIER

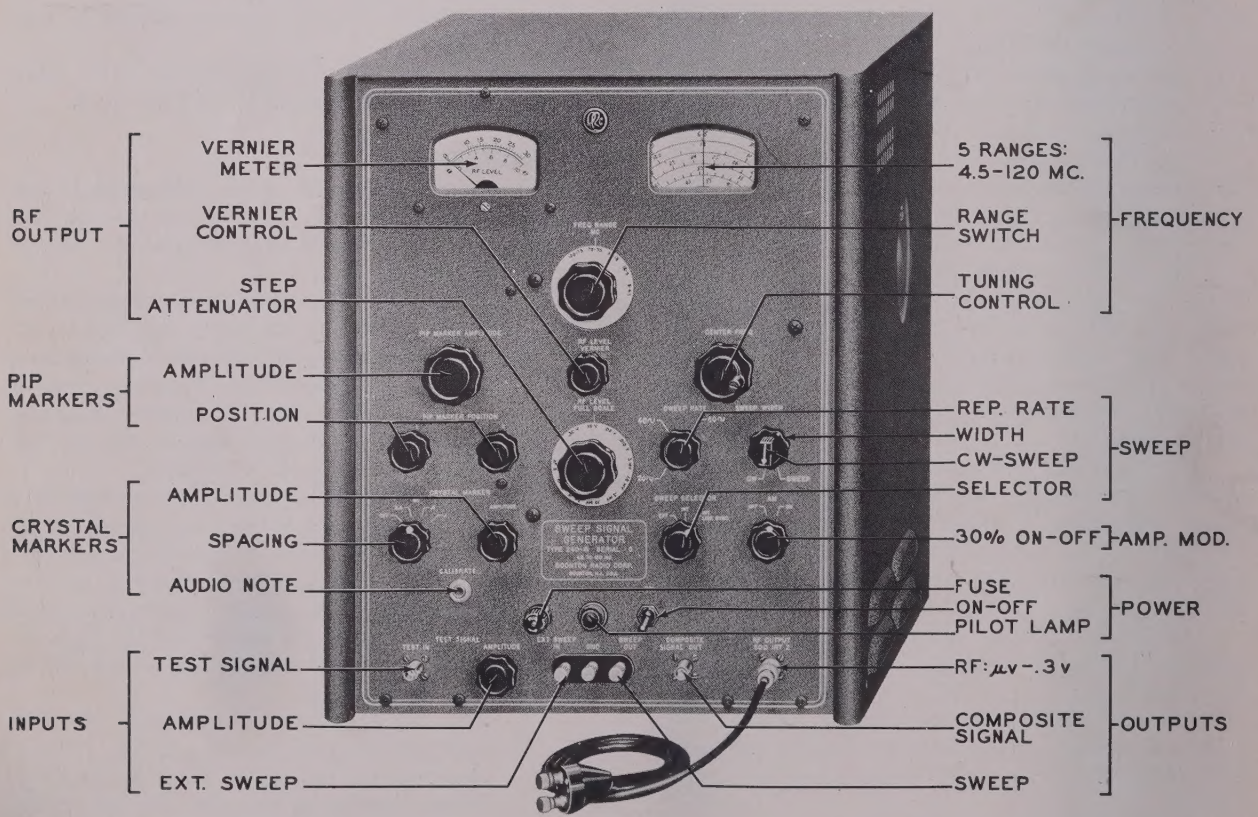


Figure II-1: Front Panel Control Layout.

control. The output voltage calibration is in terms of the open-circuit voltage appearing across the terminals at the end of the 501-B Cable through an equivalent source impedance of 25 ohms.

3. SWEEP

The SWEEP RATE control adjusts the repetition rate from 20 to 70 cps. The SWEEP WIDTH control, which is the outer ring of the dual concentric control, adjusts the frequency deviation. The CW-SWEEP bar selector knob disables the sweep circuits in the CW position. The EXT SWEEP IN connects to the binding post at the bottom of the panel. In the INT LINE SYNC position the SWEEP RATE must be adjusted to power line frequency.

4. PIP MARKERS

The PIP MARKER AMPLITUDE control varies the amplitude of the pulse voltage fed to the Adder Stage. The two PIP MARKER POSITION controls are identical in function and control the relative delay of two pip markers from the beginning of the trace.

5. CRYSTAL MARKERS

The CRYSTAL MARKER AMPLITUDE control varies the amount of MARKER voltage fed into the ADDER. The CRYSTAL MARKER SELECTOR switch indicates the frequency interval in megacycles between harmonics of the reference frequencies. The CALIBRATE jack provides an audio note for use in checking the calibration of the frequency dial against the crystal markers.

6. AMPLITUDE MODULATION

The AM Switch connects the 1000 cps audio oscillator when 30% amplitude modulation is desired.

7. INPUTS

The TEST SIGNAL IN jack connects through the TEST SIGNAL AMPLITUDE control to an amplifier which feeds the Adder. The EXT SWEEP IN binding post feeds to the EXT position on the SWEEP SELECTOR switch.

8. OUTPUTS

The SWEEP OUT binding post provides a sawtooth waveform of voltage suitable for driving the horizontal amplifier of an oscilloscope in synchronism with the sweep of the rf signal. The COMPOSITE SIGNAL OUT jack delivers from the Adder Amplifier (a) the response signal from the circuit under test obtained from the Test Signal Amplifier, (b) the Crystal Markers and (c) the Pip Markers. The RF OUTPUT jack is the output connection of the RF LEVEL FULL SCALE step attenuator.

9. POWER

The ON-OFF switch controls all input power to the instrument through the replaceable fuse. The power cord in the rear of the instrument is permanently attached to the power supply.

10. CONTROL SETTINGS

The following Table gives the positions of the controls for use as a CW Signal Generator or as a Sweep Signal Generator at a 60 cps rate.

Control	CW-AM	Sweep
FREQUENCY		
RANGE	Select Freq. Range	
CENTER FREQ.	Adjust Freq. Dial	
RF LEVEL		
FULL SCALE	Select Output Range	
VERNIER	Adjust Meter Level	
AM	OFF OR ON	OFF
CW-SWEEP	CW	Sweep
SWEEP		
SELECTOR	Not used	INT. LINE SYNC
RATE	Not used	60 cps
WIDTH	Not used	Start full cw
PIP MARKER		
AMPLITUDE	Not used	Increase cw
POSITION	Not used	Start full ccw
CRYSTAL MARKER		
AMPLITUDE	Calib. only	Increase cw
SELECTOR	Calib. only	ON then OFF
TEST SIGNAL AMPL.	Not used	Increase cw

C. OPERATIONAL CHECKS

Normal operation of the instrument can be checked as follows:

1. RF OSCILLATOR AND AMPLIFIER

After a delay of approximately 45 seconds introduced by the thermal time delay tube in the high voltage power supply, the RF LEVEL meter should rise when the RF LEVEL VERNIER knob is rotated in a clockwise direction. It should be possible to obtain full scale reading on this meter for less than full rotation of the RF LEVEL VERNIER knob at all frequencies on all bands.

With the RF LEVEL VERNIER knob turned down, the RF LEVEL meter should indicate less than the lowest calibration line, but not zero. Since this meter is monitoring the rf output immediately ahead of the attenuator system, this check proves that the Power Supply, Oscillator and Buffer Amplifier systems are operating satisfactorily.

2. RF OUTPUT ATTENUATORS

Set the FREQUENCY RANGE control on the 4.5-9.0 MC range, the CW-SWEEP selector to CW, and the FREQUENCY DIAL, by means of the CENTER FREQUENCY knob, to 5 MC. A suitable vacuum tube voltmeter connected across the terminals of the Cable Type 501-B should show an RF voltage when the RF LEVEL VERNIER and RF LEVEL FULL SCALE controls are set for full output.

3. CRYSTAL REFERENCED FREQUENCIES

Connect a pair of high impedance earphones to the CALIBRATE jack, turn the CRYSTAL MARKER selector switch to 2.5 MC, and the selector to CW. A whistle, or hetrodyne beat note, should be heard in the phones as the CENTER FREQUENCY tuning control

is rotated past integral multiples of 2.5 mc. A similar check at 0.5 mc spacing and 0.1 mc spacing will demonstrate whether the CRYSTAL MARKER system is operating normally. It will also serve to check the accuracy of the frequency calibration of the FREQUENCY DIAL. During this check it is necessary to have the CRYSTAL MARKER AMPLITUDE CONTROL turned on full.

4. PIP AND CRYSTAL MARKERS

Connect the SWEEP OUT terminals to the Horizontal (X Axis) Amplifier on the oscilloscope. The gain of the oscilloscope should be adjusted to produce a normal horizontal trace. Connect the COMPOSITE SIGNAL OUT jack to the Vertical (Y Axis) Amplifier of the oscilloscope. Set the function selector to SWEEP.

In the absence of a test signal and with the CRYSTAL MARKERS turned OFF, there should appear on the oscilloscope a horizontal line containing two pip markers whose horizontal position along the trace should be adjustable by the means of the two independent PIP MARKER POSITION controls on the front panel. The amplitude of the pips should be adjustable by means of the PIP MARKER AMPLITUDE control.

The position of the pips is determined from the leading edge of the sweep, independent of sweep width. The voltage delivered to the SWEEP OUT terminals also should be independent of the sweep width. Rotation of the SWEEP WIDTH knob should not affect the position of the pip markers, nor the width of the trace on the oscilloscope.

Set the SWEEP WIDTH control about half way to maximum, turn the CRYSTAL MARKER switch on and advance the CRYSTAL MARKER AMPLITUDE—Birdie-type markers should appear on the oscilloscope. The number of marks depends on the marker separation and the SWEEP WIDTH settings.

5. TEST SIGNAL AMPLIFIER

A low audio frequency signal of approximately ½ volt applied to the TEST SIGNAL IN jack should appear at the COMPOSITE SIGNAL OUT jack as approximately 4 volts with the TEST SIGNAL AMPLITUDE control turned full on.

6. AMPLITUDE MODULATION

Connect a diode rectifier circuit across the terminals of the Output Cable and connect the rectified output to the Vertical (Y Axis) of the oscilloscope. Turn the RF LEVEL controls for full output, the function selector knob to CW, and the AM knob to ON. Adjust the internal linear sweep of the oscilloscope for about 100 cps. The rectified 1000 cps amplitude modulation should appear on the oscilloscope.

7. RF BLANKING AND FLATNESS

Use the crystal rectifier and oscilloscope connections of Item 6 with the oscilloscope sweep rate set at about 20 cps. Turn the function selector knob to SWEEP and turn the SWEEP WIDTH control up about half way.

There should appear on the oscilloscope a rectangular waveform having a width-to-separation ratio of about 2 to 1. The sides of the pulses should be square and the tops and bottoms should be flat.

D. MEASURING CIRCUIT CONNECTIONS

For use as a conventional CW or Amplitude Modulated Signal Generator, the only connection required is the RF Output Cable Type 501-B.

Figures II-2 and II-3 show typical arrangements of test equipment for measuring the pass-band of a radio frequency amplifier having its own detector.

1. RF OUTPUT

The r.f. output is obtained from the terminals of the Cable, Type 501-B, which presents a source impedance of 25 ohms. The open circuit voltage, acting in series with 25 ohms, is indicated by the combination of the meter and the RF LEVEL FULL SCALE dial. An additional 25 ohm series resistor must be placed between the high terminal of the 501-B Cable and the input to a 50 ohm receiver.

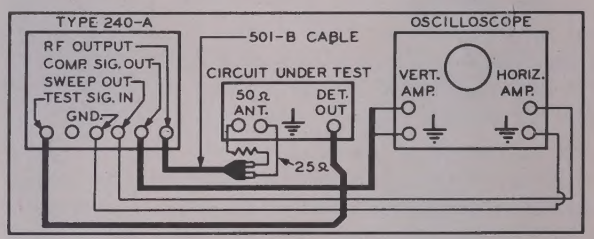


Figure II-2: Use of Output Cable Type 501-B

2. TEST SIGNAL IN

The detected output voltage of the circuit under test is fed to the TEST SIGNAL IN jack.

3. SWEEP OUT

The SWEEP OUT and GND terminals are connected to the Horizontal, or X-Axis, Amplifier of the oscilloscope.

4. COMPOSITE SIGNAL OUT

The COMPOSITE SIGNAL OUT jack is connected to the Vertical, or Y-Axis, Amplifier of the oscilloscope. This signal contains the response pattern of the system being tested, the Crystal Markers, if they are turned ON, and the Pip Markers.

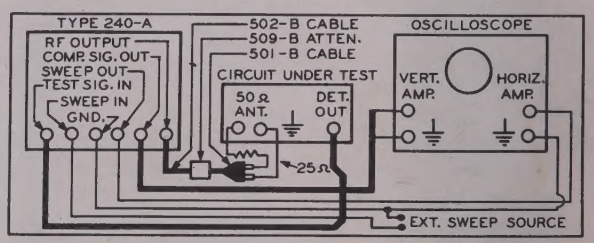


Figure II-3: Use of Attenuator Type 509-B

When a 20 db Attenuator Type 509-B is inserted between a 502-B Cable and a 501-B Output Cable as shown in Figure II-3, all output readings on the signal generator should be divided by 10. The unloaded output voltage appearing across the terminals at the end of the 501-B Cable will be 1/10 the voltage read on the dials in series with 50 ohms source impedance.

SECTION III
SPECIFICATIONS

OPERATION AS A CW SIGNAL GENERATOR

RF Frequency Range: 4.5 to 120 MC continuously variable in five self-contained ranges. Output frequencies are the fundamental oscillations of the generator.

RF Frequency Accuracy: ±1% after suitable warmup period.

RF Frequency Calibration: A detector and front panel phone jack are available for calibration of the main tuning dial against internal crystal-controlled frequencies spaced 0.1, 0.5 or 2.5 MC apart.

Calibrated RF Output Voltage Range: Continuously variable from 1 to 300,000 microvolts across 50 ohm load provided by standard output cable (Type 501-B). Range may be shifted to 0.1 to 30,000 microvolts by use of externally connected attenuator (Type 509-B).

RF Output Voltage Accuracy: Approximately ±10% of full scale "RF Level" meter readings.

RF Output Impedance: 50 ohms unbalanced looking into front panel BNC Connector. 25.0 ohms unbalanced looking into standard output cable (Type 501-B). 50 ohms unbalanced looking into externally connected attenuator (Type 509-B).

Amplitude Modulation: Available by operation of front panel switch from internal 1000 cps oscillator. Factory adjusted to approximately 30%.

General: Short term RF frequency stability, constancy of RF frequency with changes in output level and load, AM noise modulation, hum frequency modulation and leakage have all been held to very tight tolerances consistant with the performance of our other Signal Generators.

OPERATION AS A SWEPT FREQUENCY RF SIGNAL GENERATOR

RF Frequency Range: Center frequency of swept frequency excursion, 4.5 to 120 MC, continuously variable in five self-contained ranges. Output frequencies are the fundamental oscillations of the generator.

Center Frequency Accuracy: ±1% after suitable warmup period.

RF Output Voltage Range: Same as specified for operation as a CW Signal Generator. Output is continuously monitored and indicated.

RF Output Voltage Accuracy: Approximately ±10% of full scale "RF Level" meter readings.

Flatness of Output Level of Swept RF Frequency: Better than 7% while sweeping for any combination of output, center frequency and sweep width.

RF Output Impedance: Same as specified for operation as a CW Signal Generator.

Range of Sweep Widths: Continuously variable from a minimum of ±1% of center frequency to a maximum of ±15 MC or ±30% of center frequency whichever is smaller.

Sweep Repetition Rates: Variable from 20 to 70 cps. Capable of synchronization with the line frequency.

Sweeping from External Voltage Source: Provision has been made for sweeping the RF frequency from an external source. Maximum specified sweep width can be obtained over a sweep repetition rate of 20 to 200 cps decreasing to ±5% of maximum specified sweep width at 1000 cps.

Linearity of Swept RF Frequency: Frequency deviation vs low frequency sweep output voltage linear within 10% over ±80% of the sweep excursion measured from the center frequency. Linearity of remainder of sweep within 20%.

Blanking of Swept RF Frequency Output: The RF output is reduced to zero during the return frequency sweep to provide a zero base line on the display.

Low Frequency Sweep Voltage Output: The voltage that sweeps the RF frequency is available at the front panel for sweeping an oscilloscope. Minimum of 20 volts peak to peak of triangular waveform independent of RF sweep width available.

General: Constancy of center frequency with changes in output level, load or sweep width and variation of output level with changes in sweep width have been held to close tolerances.

Crystal Markers: Crystal birdie type markers switchable to spacing of 0.1, 0.5 or 2.5 MC available. Accuracy of crystal reference frequencies ±0.005%. Birdie type markers may be controlled in amplitude and switched off. Center birdie on display is identified by frequency setting of tuning dial.

Pip Markers: Two stable, rectangular markers adjustable to any position on the sweep excursion available for marking frequencies determined by birdie markers after birdie type markers are switched off. Pip markers amplitude may be controlled.

Internal Mixer Stage: Internal mixer adds the birdie and pip type markers to the signal from the circuit under test and feeds composite signal to an output connector. Mixer stage gain approximately 10 over input level range of 0.1 to 5.0 volts peak to peak.

Power Source Requirements: 105-125 volts 60 cps only approximately 280 watts—Type 240 A-P available for operation from 105-125 volts 50 cps only approximately 280 watts.

Dimensions: Height 18", Width 15¼", Depth 20¼".

Weight: 76 pounds.

Tube Complement:

1 OA3	1 6AL5	1 6N030
2 5718	2 6AQ5	1 6U8
1 5651	1 6AS76	1 12AT7
1 5U4C	1 6AU6	6 12AU7
1 6AK5	1 6BJ7	5 12AX7
	1 6BK7A	

Accessories: Supplied with instrument: Cable Type 501-B.

SECTION IV
PRINCIPLES OF OPERATION

A. BLOCK DIAGRAM

Figure IV-1 shows the functional block diagram of the Sweep Signal Generator Type 240-A. It consists of four instruments plus a power supply in a single case:

1. A Precision CW Signal Generator, AM modulated
2. A Sweep Frequency Generator
3. A Crystal-Controlled Source of Reference Frequencies and an Adder Stage
4. A Double-Pip Interpolation Marker Generator

Each of these functions will be discussed separately.

1. PRECISION CW SIGNAL GENERATOR

The frequency band from 4.5 to 120 mc is tuned in five ranges by a variable air capacitor and five oscillator coils. The oscillator operates at the fundamental frequency marked on the frequency dial. The broad-band, untuned buffer-amplifier feeds this signal to a variable 10 db "L" pad attenuator which is followed by a step attenuator having 10 steps of 10 db each. A diode voltmeter monitors the output of the "L" pad. The attenuator system produces calibrated voltage levels at the output of the cable, ranging from 0.3 volt full scale to 1 microvolt at the lowest calibration point on the monitoring voltmeter combined with the maximum attenuation of the step attenuator.

Stray field leakage from the instrument has been held at a sufficiently low level so that an external 20 db pad, such as the Attenuator Type 509-B, can be used for making measurements below the range of the direct output of the generator.

In shunt with the output system is a crystal diode amplitude modulator adjusted for modulating the output to 30%. A 1000 cps audio oscillator drives the amplitude modulator. When used in conjunction with the self-contained crystal-referenced harmonic generator, the frequency calibration can be spot checked by means of phones connected to the calibrate output jack on the front panel.

2. SWEEP SIGNAL GENERATOR

The radio frequency signals described above may be caused to deviate about the center frequency by varying the magnetic flux passing through the ferrite cores upon which are wound the five oscillator coils. The dc current through a coil and yoke assembly establishes the correct operating point for the saturable reactors.

The current waveform necessary to produce linear deviation of frequency is generated from the output of an adjustable-frequency multivibrator circuit covering the frequency range from 20 to 70 cps. It may be synchronized at line frequency. A triangular waveform of voltage appears at the front panel of the instrument for driving the horizontal sweep of the display oscilloscope.

The width of sweep is adjustable and is symmetrical about the center frequency which is shown on the frequency tuning dial. A binding post on the front panel permits the use of external sweeping voltages in place

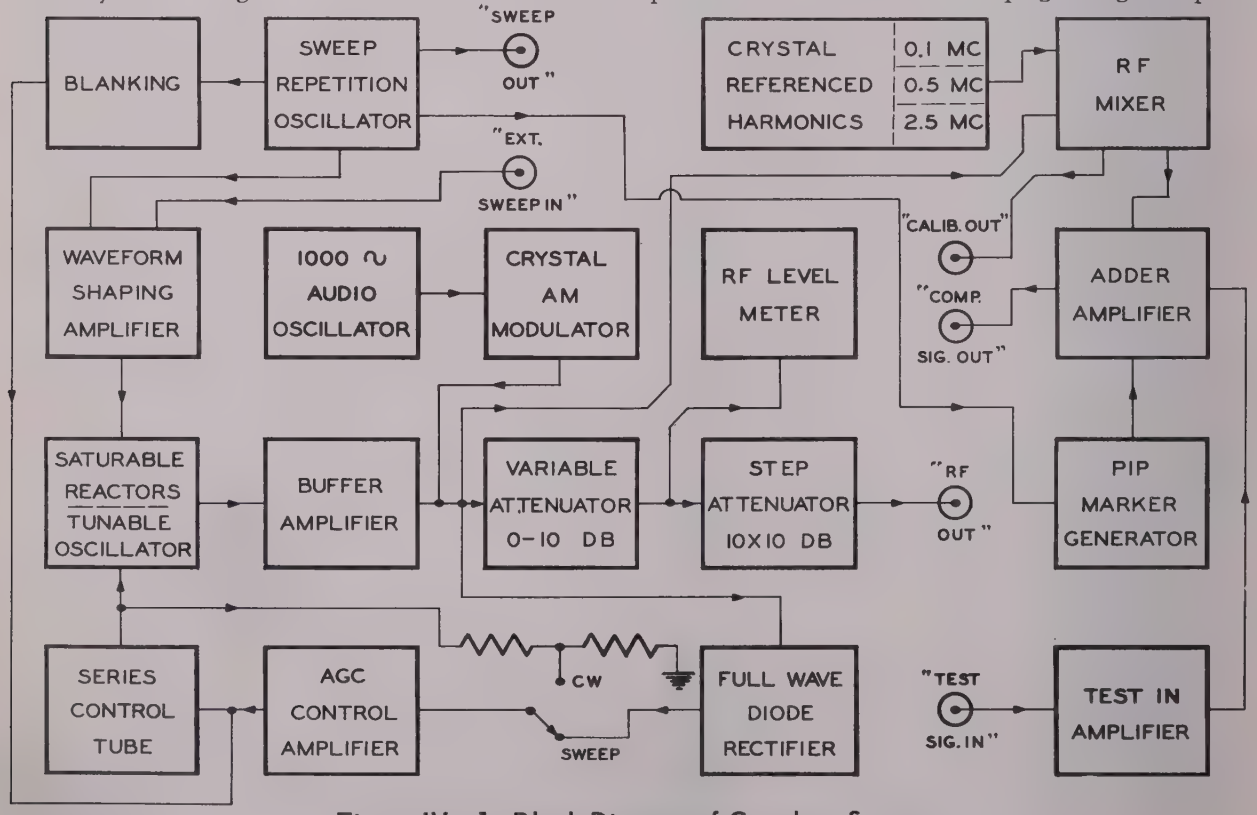


Figure IV–1: Block Diagram of Complete System.

of those generated internally. An automatic gain control system holds the output constant while the frequency is being swept.

The attenuator output system and level-monitoring meter apply equally to the CW, AM and Swept outputs.

3. CRYSTAL-CONTROLLED REFERENCE FREQUENCIES AND ADDER STAGE

A set of reference frequencies which are harmonically related is generated by a system of three oscillators referenced to a quartz crystal. A front panel control permits the choice of harmonically related frequencies spaced 2.5 mc, 0.5 mc or 0.1 mc. The choice depends on the bandwidth of the signal circuit under test and the center frequency.

The spectrum of harmonically related frequencies is heterodyned with the swept r.f. output of the buffer-amplifier in a mixer stage to produce a series of audio frequency beat notes, passing through zero beat as the swept frequency passes through the reference frequencies. These audio frequency beat notes, sometimes called "birdies", are fed to an audio frequency Adder Amplifier.

The rectified response from the circuit under test is fed into the Test Signal Amplifier and combined with the birdie markers, thus producing a "COMPOSITE SIGNAL OUTPUT" which provides accurate identification of the instantaneous frequency being applied to the input of the system under test.

The reference frequencies can be used for calibrating the frequency dial of the signal generator system.

4. PIP MARKER GENERATOR:

A unique feature of this instrument is the inclusion of two sharp, rectangular "pip" markers whose horizontal position on the oscilloscope trace can be controlled independently from each other and whose position is synchronized with the beginning of the sweep trace. This system makes it possible to accurately mark the center of the birdie type markers on a display pattern. When the crystal reference birdie markers are turned off by the front panel control, there remain on the oscilloscope display the clean-cut, pip markers which identify the center of the reference frequencies with crystal accuracy without disturbing the pass-band pattern.

Either or both of these pip markers can be used as interpolation markers to identify frequencies other than those provided by the crystal markers if a ruled grid is used on the oscilloscope screen. The two markers can be controlled simultaneously in amplitude or can be displaced completely to the left hand end of the trace if their use is not required.

5. POWER SUPPLY

Filament power for critical tubes is obtained through a voltage-regulating transformer which must match the frequency of the power source: 60 cps. for the Type 240-A; 50 cps. for the Type 240-AP. High voltage and bias supplies contain electronic glow discharge type voltage regulator systems to assure stable operation from 105-125 volts.

B. SCHEMATIC CIRCUIT DIAGRAM

The Schematic Circuit Diagram folded in at the end of this manual is divided for convenience into the same grouping of components as occurs physically on the various sub-assemblies in the instrument.

Component Circuit Symbol Numbers are assigned by blocks of 100's in accordance with the following table:

100's—Pip Chassis
200's—Marker Chassis
300's—Audio Chassis
400's—R.F. Unit and Meter
500's—Sweep Chassis
600's—Power Supply

The Tabulated List of Parts immediately preceeding the Schematic Circuit Diagram follows this same arrangement.

In the following sections, the order of discussion follows the order of the functions of an elementary signal generator, to which are added the various special circuit features required for sweeping and marking. The Schematic Circuit Diagram should be unfolded for constant reference while reading the following descriptions.

1. RF OSCILLATOR AND REACTORS

The oscillator of the Signal Generator Type 240-A operates at the output frequency shown on the frequency dial on all bands. It consists of two Type 5718 Tubes, V-402 and V-403, operating in a push-pull oscillator circuit. The full frequency coverage of 4.5 to 120 megacycles is covered in five bands, each of which has its own center-tapped coil, L-401B through L-405B, wound on ferrite cores.

The ferrite cores have the property of changing their effective permeability as a function of the magnetic flux flowing through the core parallel with the axis of the coil. In operation this flux has two components. The dc component, produced by the steady value of dc current through the exciting winding of the yoke system, provides the proper inductance at the center frequency. Superimposed on this direct current in the yoke coil is an alternating current consisting of an essentially triangular waveform of current which has been shaped in such a manner that the net change of frequency of the circuit will be linear with respect to the voltage delivered to the SWEEP OUT binding post.

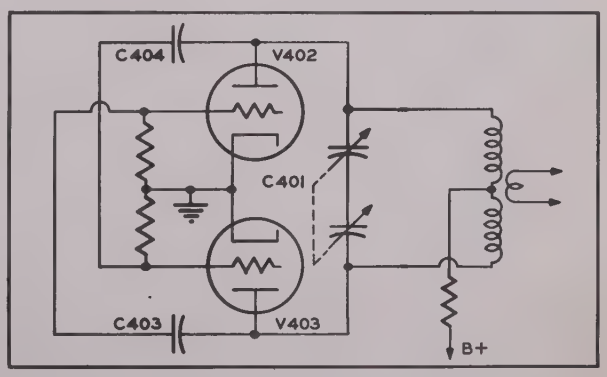


Figure IV–2: RF Oscillator, Basic Circuit.

Shaping of the current is required for two reasons. First, the ferrite does not respond linearily to the driving flux over the entire sweep range. Secondly, even if the ferrite produced a linear change of inductance of the coil itself as a function of current, the frequency would not change linearily due to square root relation between inductance and frequency and also because of the fact that the amount of varying inductance contained on the coil winding itself is in series with the fixed inductance of the switch and leads. It is therefore necessary to pre-emphasize the high current portion of the waveshape independently on each band. See "Shaping Circuits" for details.

The filaments of the oscillator tubes are fed from the voltage regulating transformer T-602 through T-604. The plate supply to the oscillator is fed through a series regulator tube, V-509, which controls the output amplitude of the oscillator. This control signal is derived either from the automatic gain control amplifier system, V-507, V-508, V-509, which monitors the output during the sweeping operation by diodes, X-402 and X-403, or from the fixed voltage divider on the plate supply of the oscillator consisting of R-567 together with the switched resistors R-507, R-508 and R-517 during CW operation.

2. BROAD-BAND AMPLIFIER

The output of the oscillator is obtained by pick-up coils L-401A through L-405A, wound on the middle of the oscillator coil assemblies. These coil connections are picked up through contacts on the rotary band switch, S-402, and fed to the input terminals of a grounded-grid, broad-band 6BK7A buffer amplifier, V-401, which covers the band of 4.5 to 120 mc. The rf voltage appearing at the output of the suppressor resistors, R-422 and R-423, feeds the input to an adjustable "L" pad attenuator, R-431A, R-431B, which is uncalibrated.

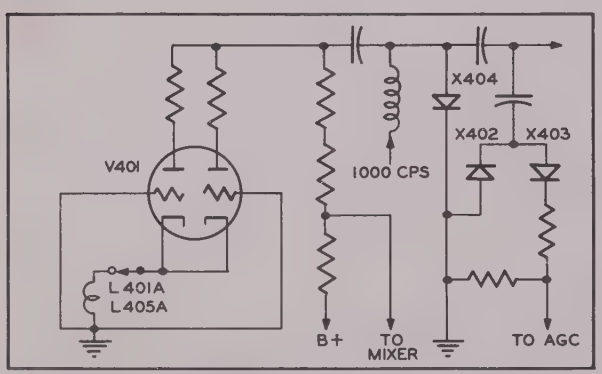


Figure IV–3: Output Amplifier and AM Modulator, Basic Circuit.

3. AMPLITUDE MODULATOR

The radio frequency voltage delivered at the output of the buffer amplifier appears across the diode modulator circuit, X-404 and L-406. The 1000 cps voltage received from the r-c audio oscillator, V-301, is applied as a dynamic operating bias on the diode X-404. This bias varies the impedance of the diode in such a manner as to form a variable shunt across the RF output system, thus producing amplitude modulation.

4. OUTPUT ATTENUATOR SYSTEM

The rf voltage from the buffer-amplifier, V-401, is delivered to an "L" pad attenuator consisting of two ganged potentiometers, R-431A and R-431B. The output of the "L" pad attenuator is monitored by a crystal diode voltmeter, X-401, whose output appears on the RF LEVEL METER, M-401, on the front panel. The "L" pad has an operating range somewhat in excess of 10db.

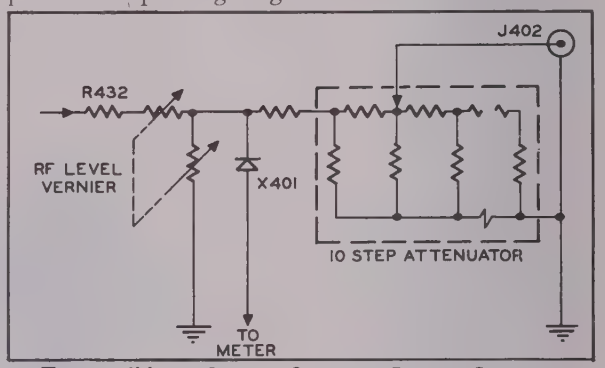


Figure IV–4: Output System, Basic Circuit.

The output of the "L" pad is fed to a 10 step attenuator unit, R-401 through R-421, having 10 db per step. The output impedance of the step attenuator is 50 ohms resistive except on the maximum output position in which the impedance rises somewhat. The output of the attenuator is connected with the front panel RF OUTPUT jack, J-402, by way of 50 ohm coaxial cable.

The equivalent voltage source of the output system is shown in the diagrams of Figure IV-5. For 50 ohms impedance, add an external 25 ohm resistor.

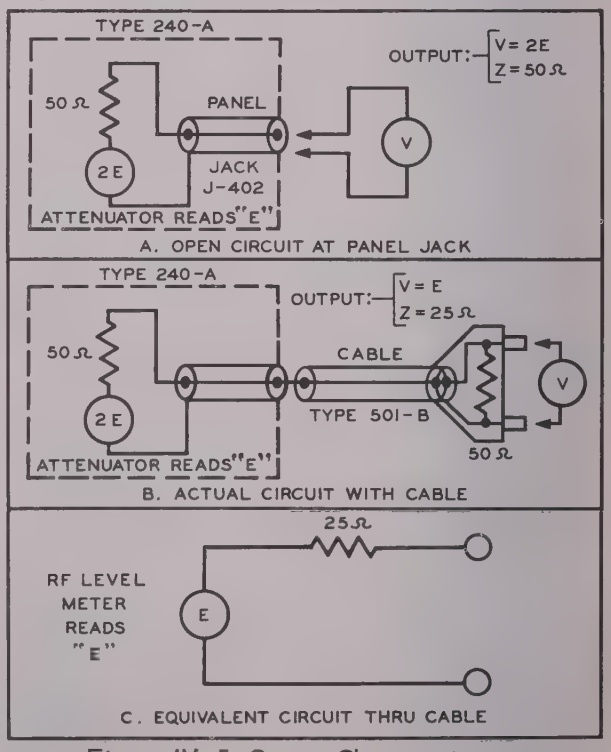


Figure IV–5: Output Characteristics.

5. SWEEP VOLTAGE GENERATOR

The repetition rate of the sweep voltage applied to the saturable reactor is controlled in the multi-vibrator oscillator V-501 by means of the ganged potentiometers R-529A and R-529B labeled SWEEP RATE. In the LINE SYNC position, voltage of power source frequency is applied to one grid, pin 7, of the V-501 multi-vibrator.

Either the output of the multi-vibrator oscillator or an external sweep voltage applied through the EXTERNAL SWEEP IN post J-501, is fed to the grid of amplifier V-502. The time constants in this circuit are chosen so as to integrate the rectangular waveform from the multi-vibrator into a triangular saw-tooth waveform. This waveform, or the EXTERNAL SWEEP waveform, is amplified in the second half of V-502 and delivered as EXTERNAL SWEEP OUT voltage through the front panel post J-503.

The SWEEP WIDTH control, R-536, feeds a controllable amount of saw-tooth voltage into the amplifier V-504 whose output appears across the cathode load resistor, R-542, of the second section, which is common with the dc amplifier, V-505.

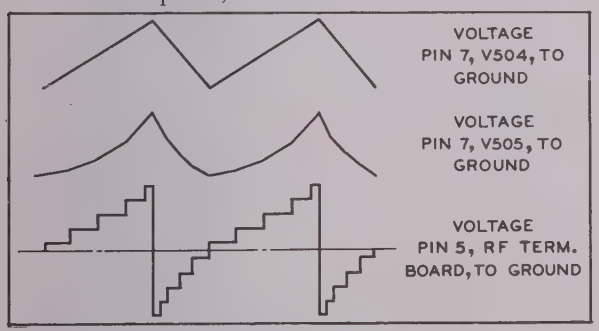


Figure IV–6: Sweep Control Waveforms.

For the reasons mentioned in IV-B-1, it is necessary to adjust the waveshape of the saw-tooth current being fed to the yokes, L-408 and L-409, in order to produce a linear deviation of frequency as a function of the original saw-tooth voltage. This is done by the cathode shaping resistor and diode combination, X-501, the triple diode, V-506, in conjunction with the compensating resistors appearing as part of Switch S 501. The bias voltages appearing across the three elements contained in the 6BJ7 tube, V-506, are controlled by the five potentiometers R-549, R-553, R-558, R-564 and R-573, which are selected by the frequency range switch.

These bias levels determine when each diode cuts into the circuit as the dc voltage on the cathode increases. The amount by which each diode changes the slope of the waveform is determined by the addition of the resistances R-548, R-552, R-557, R-563 and R-568 in the voltage divider containing R-539 from the cathode of V-504. Additional control is obtained through the diode X-501 acting on the cathode of V-505.

The center-frequency current on each band is adjusted independently for CW and for SWEEP operation by means of the two sets of five controls each associated with Sections B and C of the Range Switch S-501. In CW operation, the controls R-534, R-535, R-537, R-538, R-540, each of which is associated with one of the five frequency bands, are adjusted to produce the fixed value of current through the yoke which establishes the operating point of the saturable reactor.

In SWEEP operation, the compensating diode V-503, in conjunction with the center current resistors R-525, R-526, R-527, R-531 and R-533, establishes the center current for the sweep. The compensating diode V-503 is required to maintain the center frequency stable as the line voltage is varied and is factory adjusted by means of R-510.

6. AUTOMATIC FLATNESS CONTROL

In the RF Unit, the voltage out of the buffer-amplifier, V-401, appearing at C-406 is monitored by the full-wave crystal diode voltmeter, X-402 and X-403. This voltage is fed by way of Section E on the CW-SWEEP switch S-503 to the input of a high-gain DC amplifier consisting of the four triodes in V-507 and V-508, which controls the series regulator tube, V-509. Tube V-509 controls the plate voltage of the RF oscillator, and hence the output level.

In CW operation, the Automatic Gain Control Amplifier is referenced back to a fixed voltage divider system to provide additional stability of the oscillator circuit.

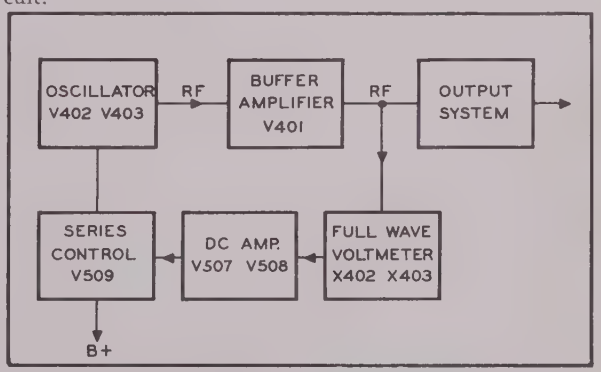


Figure IV–7: Flatness Control, Basic Circuit.

7. RF BLANKING

During the return trace on the oscilloscope, the oscillator is turned off so that a zero-reference base line is established on the display pattern for use in measuring response characteristics. This is done by applying the rectangular waveshape from the output of the multi-vibrator through C-506 to the grid number 2 of V-508.

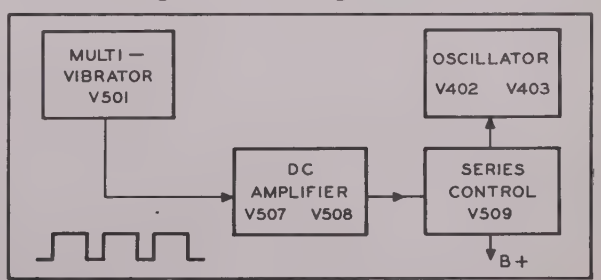


Figure IV–8: Blanking, Basic Circuit.

8. CRYSTAL MARKER GENERATOR

A 2.5 mc crystal, X-201, is used to stabilize the oscillator V-201. The oscillator plate load, L-201 and C-202, is tuned to 10 mc to produce a harmonic spectrum which will extend up to the 120 mc region of the unit. This signal is fed to the grid of V-202 which has plate loads of 2.5 mc and 0.5 mc controlled by the adjustable slugs in L-202 and L-203, respectively.

The dual triode V-204 contains two oscillators; one operating at 0.1 mc and controlled by L-207 with capacitors C-226 and C-229, the other operating at 0.5 mc controlled by L-208 and C-227. These two oscillators operate at sub-harmonic frequencies by tapping the coils into the plate load circuit of V-202, thereby producing sub-synchronous operation.

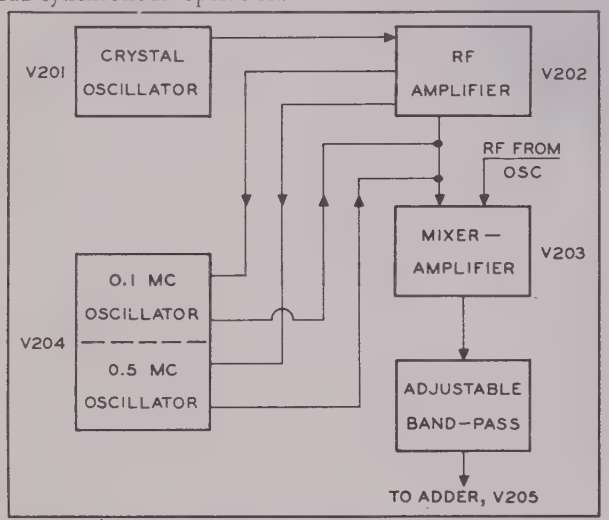


Figure IV–9: Crystal Markers, Basic Circuit.

The input to the cathode of V-203 contains harmonics of 0.1 mc, 0.5 mc and 2.5 mc. Selection of the desired combination of frequencies is obtained by switching of the power supply to the various oscillators.

The first section of V-203 constitutes a mixer. On its cathode appears a rich band of harmonics of the crystal-controlled oscillator and on its grid is placed a sample of the rf voltage delivered at the output of the buffer amplifier through the switch S-401. This switch is located inside the RF Unit and is driven by a mechanical linkage which is interlocked with the Crystal Selector Switch on the front panel. When the crystal markers are turned OFF, the coaxial switch is shorted so that no radio frequency voltage is allowed to leak out of the RF Unit.

The output of the mixer section of V-203 is fed into time constant circuits which control the gain-versus-bandwidth characteristics of the amplifier consisting of the second section of V-203. Additional bandwidth control is obtained by means of the resonant circuits in the cathode of the second section of V-203 controlled by inductors L-209, L-210A and L-210B. Additional control is obtained by means of the series resonant traps controlled by L-204 and L-205. The purpose of these bandwidth adjustments is to maintain an approximately constant ratio of the passband of the amplifier to the separation of the harmonics being observed so that the appearance of the birdie markers on the screen will be uniform regardless of frequency separation.

9. PIP MARKER GENERATOR

A trigger spike is derived from the multi-vibrator tube, V-501, and is fed to two seperate delay multi-vibrators, V-101 and V-102, by way of capacitors C-103 and C-108. These two multi-vibrators are identical and contain controls R-107 and R-119 which are labeled on the front panel of the instrument PIP MARKER POSITION #1 and #2. These controls are identical in function and may be used interchangeably regardless of the sequential numbering.

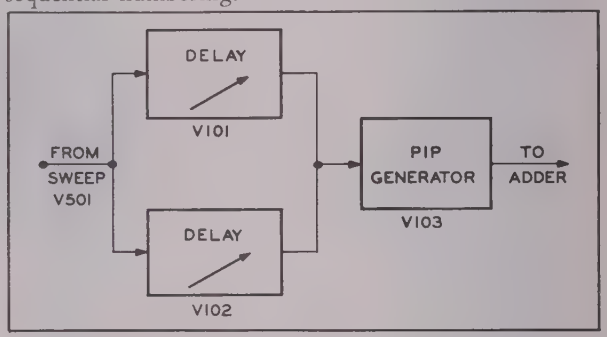


Figure IV–10: Pip Markers, Basic Circuit.

The function of the multi-vibrators is to generate two new trigger pulses having adjustable delays with respect to the trigger derived from the multi-vibrator which drives the sweep system. These two triggers are added by way of C-102 and C-107 and the diodes X-102 and X-103 into the common plate connection on the actual pip generator tube, V-103. This tube produces a narrow spike of approximately 50 microseconds width which delivers a voltage across the PIP MARKER AMPLITUDE control, R-117. The recovery time has been made sufficiently fast so that it will respond to double-pulsing from the two delay multi-vibrators when the separation is greater than approximately the 50 microsecond width of its own pulse.

The output of the Pip Marker Generator is fed to the Adder Amplifier, V-205, by way of the RC network R-230 and C-238 to the plate of the tube. The amplitude may be controlled by the front panel PIP MARKER AMPLITUDE control R-117.

10. COMPOSITE SIGNAL ADDER

The tube V-205 has impressed on its plate the pip markers from the Pip Marker Generator by way of the AMPLITUDE control R-117. The birdie markers derived from the Birdie Generator and associated switching are fed to the #1 grid of the pentode section of V-205.

The response pattern of the system under test is connected to the front panel jack J-203 labeled TEST SIGNAL IN. This signal passes through the TEST SIGNAL IN AMPLITUDE CONTROL, R-234, and drives the grid of the triode section of V-205 whose plate is common to the pentode section. The composite signal thus derived is fed to the COMPOSITE SIGNAL OUT

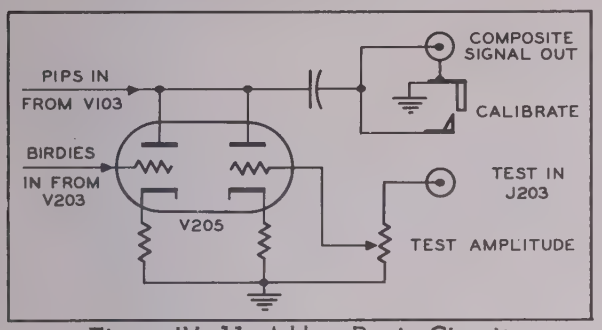


Figure IV–11: Adder, Basic Circuit.

jack, J-201, on the front panel of the instrument and also to the CALIBRATE jack for use with headphones.

11. POWER SUPPLY

The Power Supply of the Sweep Signal Generator is manufactured for either Type 240-A, 60 cps at 105 to 125 volts; or Type 240-AP, 50 cps at 105 to 125 volts. Operation on any other voltage or frequency will result in serious damage to the instrument.

The input cord to the instrument is permanently attached to the Power Supply. All power is fused by the front panel FUSE, F-601, which is contained in a replaceable type cartridge mounted on the front panel adjacent to the pilot light. A voltage stabilizer, T-602, is connected to: (a) a regulated negative supply consisting of the diode rectifier X-601 and the glow regulator type OA3 tube, V-606; (b) the full-wave crystal rectifier circuit consisting of X-602A, B, C and D and the associated filter by way of transformer T-603; and (c) the dual-winding filament transformer, T-604, whose output is used to feed critical filaments throughout the system. The main power transformer, T-601, has on it a source of unregulated filaments at 6.3 volts, the high voltage winding used to feed the plates of the high voltage rectifier, V-605, and the filaments of V-605.

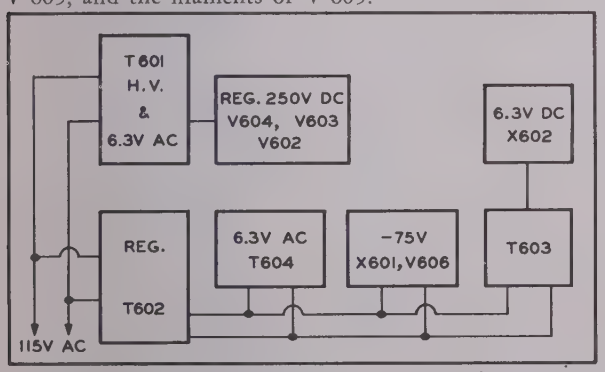


Figure IV–12: Power Supply, Basic Circuit.

The filaments of the high voltage rectifier, V-605, are fed through a thermal delay tube Type 6N030, V-601, whose filaments are driven from the unregulated 6.3 supply. This tube, V-601, introduced approximately a 30 second delay between the time of application of voltage to the filaments and closing of the contracts to the rectifier, V-605, thus delaying the application of the high voltage to all tubes in the circuit. The output of the rectifier, V-605, is fed through a series regulator tube, V-604, which is controlled in turn by the reference tube and dc amplifiers, V-602 and V-603. The output voltage is controlled by the reference potentiometers, R-608.

Additional fusing on the 250 volt line is contained in the fuse F-401. This fuse is included to protect the driving windings of the yoke, L-408 and L-409. It is located on the terminal board immediately outside of the RF Unit.

SECTION V
MAINTENANCE

A. GENERAL

The Sweep Signal Generator Type 240-A is a precision built, factory calibrated instrument. Because of the special test and calibration equipment necessary, it is in most cases not advisable to attempt field maintenance except in certain simple operations, if the initial accuracy of the instrument is to be retained.

It is the policy of the Boonton Radio Corporation to make available to its customers such service as is needed to maintain its products within specifications as advertised at a reasonable cost. Generally, all troubles other than tube replacements and routine circuit repair can best be handled at our factory. The following sections contain information which can be used to determine whether the various functions of the generator are normal and such routine maintenance as can be performed satisfactorily in the field.

1. RF UNIT

This unit has been carefully adjusted and calibrated at the factory to meet the specifications listed in this Instruction Book. Specialized testing equipment and procedures are required which make field adjustments and replacements in the unit difficult and undesirable. For this reason if any troubles are believed to have development in the RF Unit, the Signal Generator should be returned to the factory for repair and readjustment. The factory warranty is automatically voided if our inspection shows that the seal on the RF Unit has been broken.

Due to the use of coils wound on ferrite cores whose inductance can be adjusted by the external potentiometers which set the center frequency currents, there are no adjustments inside of the RF Unit except those associated with setting the minimum capacitance. Replacements of expendible components in the RF Unit, such as tubes or diodes, require readjustment of the circuits on factory test equipment not normally available to the customer. It is, therefore, unnecessary for a customer at any time to consider removing the shield can from the RF Unit.

2. ETCHED WIRING

The Sweep Signal Generator Type 240-A has in it four panels of circuitry which use etched wiring and dip solder techniques. This process was chosen for good stability and to provide a more compact unit than would otherwise be possible. The use of these techniques, rather than the older type of point-to-point wiring and terminal board construction, requires that special care be exercised in attempting any replacements of components.

In the factory assembly operation, the leads of the components are inserted through small holes in the bakelite, clipped to length, and then crimped to form a swedged end which is larger than the diameter of the hole through which the lead was inserted. This swedging operation results in a mechanical connection which prevents the component from dropping out of the hole freely when the solder is melted.

WARNING: If an attempt is made to drag the component out of the board without first snipping off the end of the crimped lead, damage to the etched wiring is bound to occur.

Certain cable connections to the etched panels are made by way of terminal lugs which are crimped into the board and rolled over against the etched wiring. If too much heat is applied to the terminals, or if undue force is applied in unwrapping the leads attached to the terminals, damage may result to the etched wiring. Cable clamps have been provided at appropriate spots to prevent undue loads from being placed on these terminals in normal operation.

In general, it is believed that the etched wiring construction will provide trouble-free operation and circuit stability characteristics not normally realized in previous types of construction. However, it must be recognized that this advantage is obtained at the disadvantage of requiring additional care in working with the components.

3. MECHANICAL DRIVES

Due to the interlocking switching between various chassis required in the design of this instrument, it has been necessary to use mechanical drives between the front panel controls and the RF Unit, the Sweep Chassis, and the Birdie Marker Unit. These drives are factory-adjusted to provide positive indexing and smooth operation.

In order to remove the detent loads from the flexible shaft and coupling, the detent assemblies have been placed as close as possible to the point of application of force, the knob. In the case of some of these switch assemblies, there is an additional detent located at the switch itself. In the case of the Birdie Chassis, this is not true. It is, therefore, necessary to assure that the indexing of the index detent plate and the switch contacts are in proper alignment.

The FREQ CONTROL knob uses a friction drive to the capacitor and frequency dial assembly on the RF Unit. The stop for the capacitor and dial rotation is located in the mechanical system at such a point as to protect the capacitor and frequency dial from accidental over-travel of the control knob. However, the accuracy of the instrument depends on the proper operation of split anti-backlash gears and the free movement of the bearings associated with this gear train.

It is of the utmost importance that no additional lubricants be placed on any switch contacts as only a limited variety of materials are suitable for this purpose. The use of improper switch lubricants at any point in the system will result in eventual faulty operation and possible complete failure of the circuits affected.

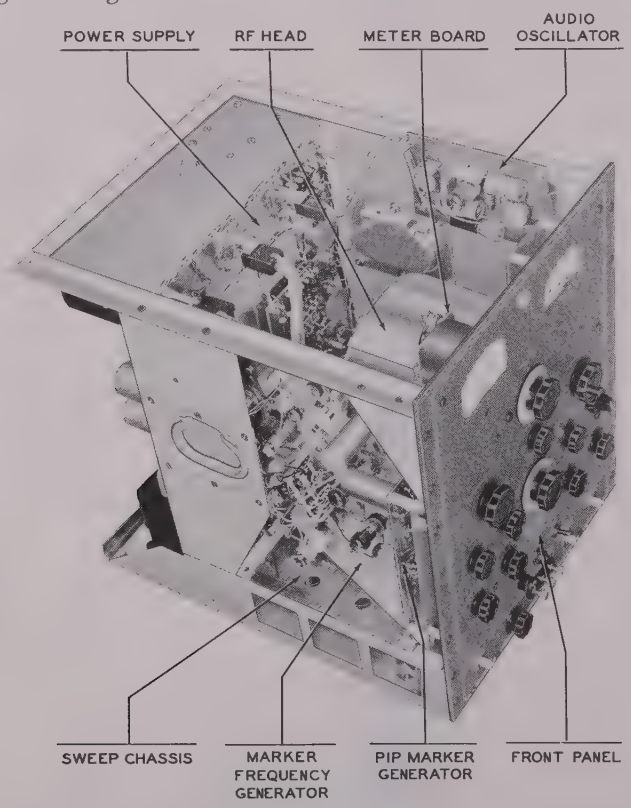


Figure V–1: Identification of Major Sub-Assemblies.

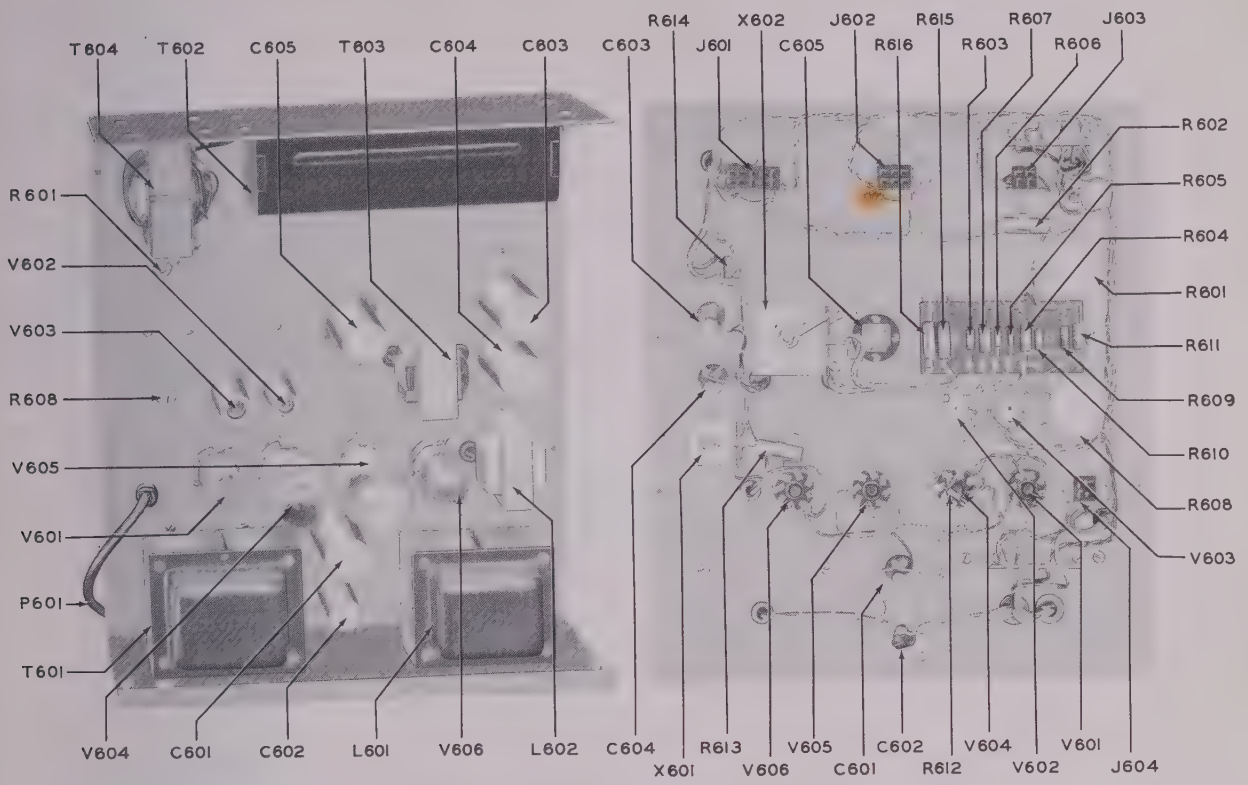


Figure V–2: Rear and Front View of Power Supply.

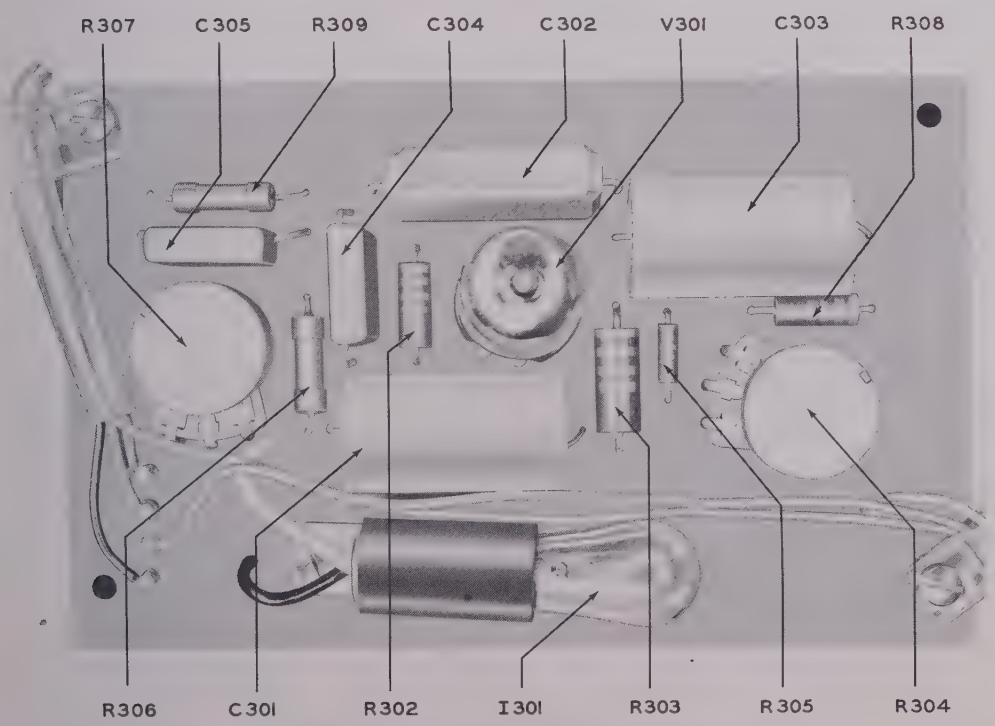


Figure V–3: Audio Oscillator Chassis.

B. REMOVING THE INSTRUMENT FROM ITS CABINET

The cabinet of the Sweep Signal Generator Type 240-A consists of two pieces. The top, two sides and rear form a dust cover which slips down from the top. It is held in place by four screws located at the bottom edge of the dust cover. The bottom plate is screwed into the bottom of the instrument frame and carries on it the four rubber feet.

To remove the dust cover, remove the two screws at the bottom of each side panel. Carefully slide the cover up over the frame and front panel of the instrument, feeding additional slack of the line cord through the opening at the rear of the cover and tipping the cover backwards. The entire inside of the instrument with the exception of the RF Unit is now accessible on the wiring side. To gain access to the tube side of the sweep chassis, rock the instrument on to the back of the frame. Remove the four mounting screws and remove the plate.

When replacing the dust cover, tip the cover backward slightly until the line cord has cleared the top of the frame.

C. REPLACEMENT OF TUBES

The circuit symbol and commercial tube designation of all tubes used in the instrument, except those contained in the RF Unit, are included on the etched wiring beside the tube sockets. In the case of the Power Supply chassis the numbers are stamped on the metal chassis. On the Sweep Chassis the circuit symbol designation also is silk-screened beside the socket on the tube side of the chassis.

The instrument has been designed to meet the specification performance as initially adjusted at the factory with tubes meeting standard commercial specifications. However, since the frequency calibration is dependent upon the currents flowing in the reactors, differences in the mutual conductance of different tubes of the same type may degrade the initial accuracy of adjustment. The circuits primarily affected are those associated with the control of the currents flowing in the yoke assembly.

If it becomes necessary to replace tubes, care should be taken to check the performance of the instrument, referring to the sections on Operational Checks and Principles of Operation. Since all tubes are operated well within specification limits the initial adjustments of the instrument should remain within specification performance over the normal anticipated life of commercial available tubes.

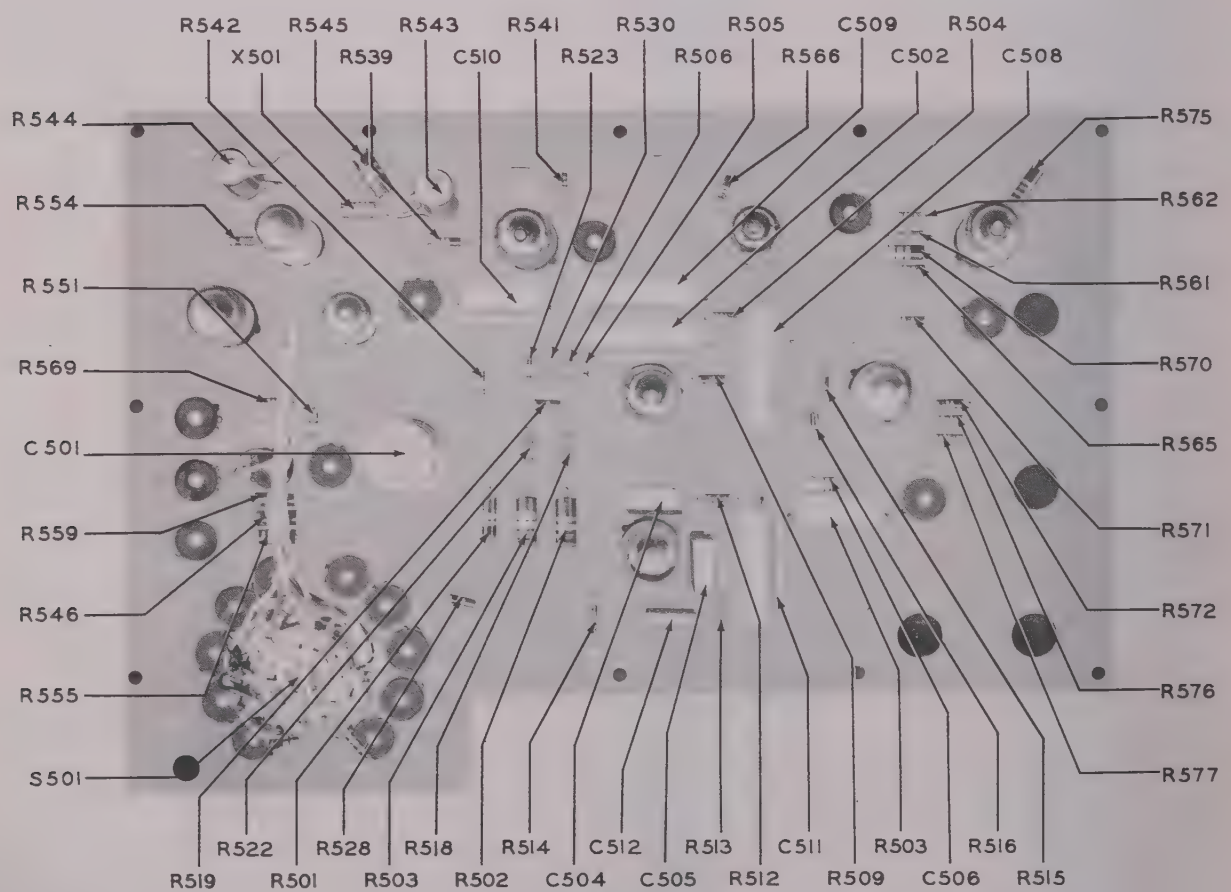


Figure V–4: Sweep Generator Chassis.

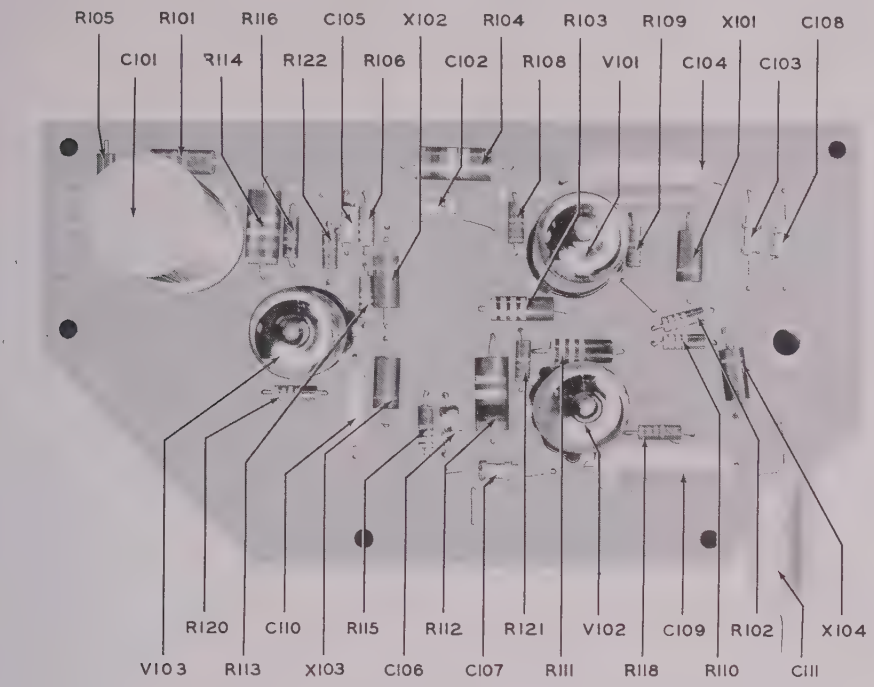


Figure V–5: Pip Marker Generator Chassis.

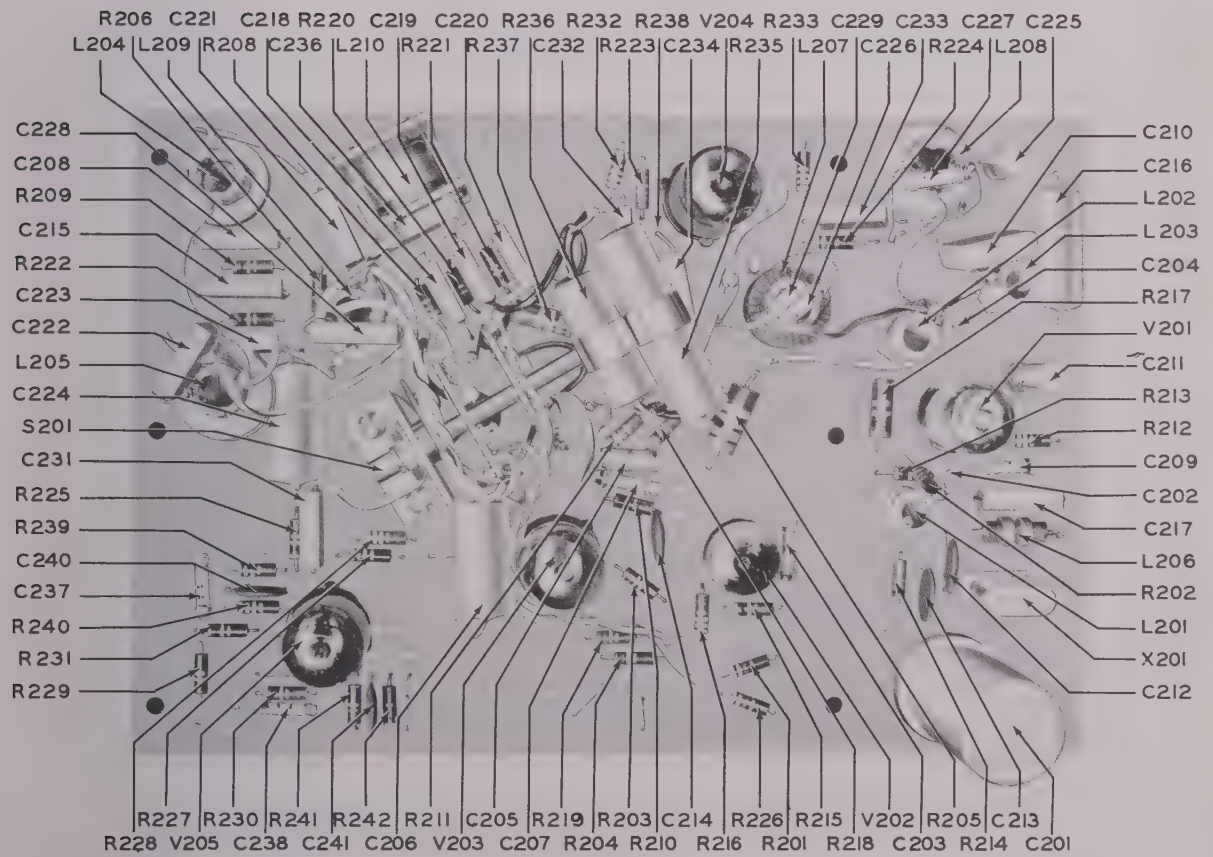


Figure V–6: Birdie Marker Generator and Adder Chassis.

TROUBLE CHART

SYMPTOM	POSSIBLE CAUSE	CORRECTION
With equipment connected to a suitable 115 volt source and Power Switch "ON", Pilot Light does not light.	Fuse defective.	Replace Fuse F601.
	Pilot Light defective.	Replace Pilot Light I601.
	Primary winding or filament secondary winding of Power Transformer open.	Check continuity of Transformer T601 and replace if defective.
All vacuum tube filaments do not light.	Defective vacuum tube.	Check vacuum tube and replace if defective.
	Primary winding or secondary windings of Fliment Transformer open.	Check continuity of Transformer T603 and/or T604.
	Defective Selenium Rectifier or Capacitor.	Check Rectifier Bridge X602 and Capacitor C605 and replace if defective.
	Defective Voltage Stabilizer.	Check continuity of T602.
Fuse F601 blown repeatedly as soon as or sometime after power is applied.	Vacuum Tube Rectifier, Filter Capacitors, Power Transformer or Voltage Stabilizer defective.	Remove Rectifier V605. If fuse does not blow check C601 and C602 for possible shorts. If normal, check V605. If normal, check continuity of T601 and T602.
Filaments light but no plate voltage.	Vacuum Tube Rectifier defective.	Check V605 and replace if defective.
	Filter Choke defective.	Check continuity of L601 and replace if defective.
	Filter Capacitor defective.	Check C601 and C602 for possible shorts and replace if defective.
No negative DC voltage.	Defective Selenium Rectifier.	Check X601 and replace if defective.
	Defective Capacitors.	Check C603 and C604 for possible shorts.
	Defective Filter Choke.	Check L602.
Birdie and Pip Markers missing from display.	Defective Adder Stage.	Check V205 and replace if defective.
		Check connections to Composite Signal Out Jack J201.
		Check C235 for possible open.

TROUBLE CHART—Continued

SYMPTOM	POSSIBLE CAUSE	CORRECTION
No audible signal from Calibrate Jack.	Defective connection.	Check connection to Calibrate Jack J202.
Birdie Markers missing from display.	Defective RF Sample Switch.	Check mechanical linkage from Marker Selector Switch S201 to RF Sample Switch S401.
With Marker Selector Switch on .5, oscillations of large amplitude cover entire display.	Poor lock-in.	Adjust trimmer capacitor C225.
Same as above on .1 position.	Poor lock-in.	Adjust Choke L207.
No Pip Marker.	Defective Pip Marker Multivibrator.	Check display at pin 1 of V103. If pips are present check V103. If tube is good, check C111 for open and check for bad connection to Adder Stage.
	No signal from Sweep Multivibrator.	Check connections from Multivibrator V501 to tubes V101 and V102.
One Pip Marker missing from display.	Defective Pip Marker Multivibrator.	Determine tube involved by operating Pip Marker Position Controls. Check tube involved, V101 or V102, and replace if defective.
No sweep voltage.	Sweep Multivibrator defective.	Check V501 and replace if defective.
	Shorted Capacitor.	Check C513 and C514 and replace if defective.
High Sweep Voltage.	Open Capacitor.	Check C513 or C514 for possible open condition.
No Audio Modulation.	Defective Audio Oscillator.	Check V301 and replace if defective.
Fuse F401 blows repeatedly.	Excessive sweep voltage.	Return to BRC.
RF Unit inoperative.		Return to BRC.

SOCKET VOLTAGE CHART

All voltages are dc unless otherwise indicated.
All measurements are approximate and are made using high impedance vacuum tube voltmeter.

CW CONDITION

1. Power Switch "ON"
2. PIP MARKER AMPLITUDE fully CW
3. PIP MARKER POSITION 1 and 2 fully CCW
4. CRYSTAL MARKER AMPLITUDE fully CW
5. CRYSTAL MARKER selector set to ".1"
6. FREQUENCY RANGE MC set to "75–100"
7. CENTER FREQUENCY set to "120"
8. RF LEVEL FULL SCALE set to ".1V"
9. RF LEVEL VERNIER set for "10" on meter
10. SWEEP SELECTOR set to "INT"
11. SWEEP RATE set to "60"
12. SWEEP SWITCH set to "CW"
13. SWEEP WIDTH fully CW
14. AM "ON"

SWEEP CONDITION

1. Same as for CW
2. Same as for CW
3. Same as for CW
4. Same as for CW
5. Same as for CW
6. Same as for CW
7. Same as for CW
8. Same as for CW
9. Same as for CW
10. Same as for CW
11. Same as for CW
12. Sweep Switch set to "SWEEP"
13. Same as for CW
14. AM "OFF"

CW CONDITION

SOCKET PIN	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10
V101 12AU7	128	20	20	0 ac	0 ac	220	0	20	6.3 ac	-
V102 12AU7	114	20	20	0 ac	0 ac	220	0	20	6.3 ac	-
V103 12AU7	220	0	20	0 ac	0 ac	120	18	20	6.3 ac	-
V201 6AU6	-17	0	0 ac	6.3 ac	250	122	.04	-	-	-
V202 6AK5	-3.3	0	6.3	0	220	155	0	-	-	-
V203 12AX7	200	-1.3	6.3	6.3	6.3	175	-.22	.25	0	-
V204 12AU7	230	-70	12.3	6.3 ac	6.3 ac	235	-138	0	0 ac	-
V205 6U8	94	0	95	0	6.3	94	2.8	2.5	0	-
V301 12AU7	95	0	3.3	0 ac	0 ac	200	0	7	6.3 ac	-
V401 6BK7A	120	0	0	0 ac	6.3 ac	120	0	0	NC	-
V402 5718	-5.8	NC	6.3 ac	NC	0 ac	0 ac	NC	155	-	-
V403 5718	-5.8	NC	0 ac	NC	0 ac	6.3 ac	NC	155	-	-
V501 12AT7	-.3	-.18	0	6.3 ac	-.32	-.25	0	0	0 ac	-
V502 12AX7	170	-.78	0	6.3 ac	6.3 ac	250	9	11.2	0 ac	-
V503 6AL5	-17	-17	0 ac	6.3 ac	-17	NC	-17	-	-	-
V504 12AU7	124	.01	5.5	6.3 ac	6.3 ac	250	-17	-4.5	0 ac	-
V505 6AQ5	0	.05	0 ac	6.3 ac	0	-1.3	0	-	-	-
V506 6BJ7	0	-6	NC	6.3 ac	0 ac	.08	0	.15	0	-
V507 12AX7	250	3.1	5	6.3 ac	6.3 ac	70	4.3	5	0	-
V508 12AX7	150	-62	.12	0 ac	0 ac	152	-1.5	0	6.3 ac	-
V509 6AQ5	152	152	0 ac	0 ac	250	250	152	-	-	-
V601 6N03 0	NC	0 ac	6.3 ac	NC	33 ac	NC	33 ac	NC	-	-
V602 5651	NC	NC	NC	NC	85	NC	0	-	-	-
V603 12AX7	200	125	125.	0 ac	0 ac	125	58	58	6.3 ac	-
V604 6AS7G	200	380	250	200	380	250	6.3 ac	0 ac	-	-
V605 5U4G	NC	36 ac	NC	400 ac	NC	400 ac	NC	420	-	-
V606 OA3	NC	-75	NC	NC	0	NC	NC	NC	-	-
J601 Sweep	6.3 ac	0 ac	NC	115 ac	165	250	-75	0	0 ac	0 ac
J602 Marker	6.3 ac	0 ac	0	250	6.3	0	-	-	-	-
J603 Audio	0 ac	6.3 ac	250	0	-	-	-	-	-	-
J604 Panel	0 ac	64 ac	6.3 ac	64 ac	-	-	-	-	-	-
RF Term. Bd.	6.3 ac	0 ac	165	160	230	250	1	3.2	-1.4	-

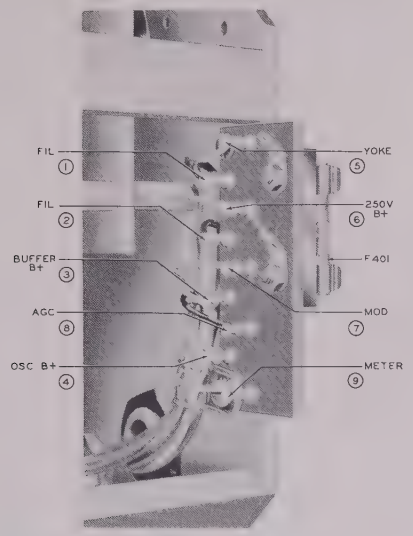


Figure V–7: RF Unit Terminal Board.

SWEEP CONDITION

SOCKET PIN		No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10
V101	12AU7	128	20	20	0 ac	0 ac	220	0	20	6.3 ac	-
V102	12AU7	114	20	20	0 ac	0 ac	220	0	20	6.3 ac	-
V103	12AU7	220	0	20	0 ac	0 ac	120	18	20	6.3 ac	-
V201	6AU6	-17	0	0 ac	6.3 ac	250	122	.04	-	-	-
V202	6AK5	-3.3	0	6.3	0	220	155	0	-	-	-
V203	12AX7	200	-1.3	6.3	6.3	6.3	175	-.22	.25	0	-
V204	12AU7	230	-70	12.3	6.3 ac.	6.3 ac	235	-138	0	0 ac	-
V205	6U8	94	0	95	0	6.3	94	2.8	2.5	0	-
V301	12AU7	0	0	0	0 ac	0 ac	-.9	-.65	-.65	6.3 ac	-
V401	6BK7A	125	2.6	0	0 ac	6.3 ac	125	0	0	NC	-
V402	5718	-4.2	NC	6.3 ac	NC	0 ac	0 ac	NC	110	-	-
V403	5718	-4.2	NC	0 ac	NC	0 ac	6.3 ac	NC	110	-	-
V501	12AT7	150	-23	0	6.3 ac	6.3 ac	190	-42	0	0 ac	-
V502	12AX7	185	-.92	0	6.3 ac	6.3 ac	250	90	11.2	0 ac	-
V503	6AL5	-17	-18	0 ac	6.3 ac	-17	NC	-17	-	-	-
V504	12AU7	124	0	5.5	6.3 ac	6.3 ac	250	-17	-2.8	0 ac	-
V505	6AQ5	11	27	0 ac	6.3 ac	220	250	11	-	-	-
V506	6BJ7	11	-8.5	NC	6.3 ac	0 ac	-3.2	11	1	11	-
V507	12AX7	250	2.6	4.2	6.3 ac	6.3 ac	45	3.8	4.3	0 ac	-
V508	12AX7	82	-90	-68	0 ac	0 ac	82	-11.5	0	6.3 ac	-
V509	6AQ5	82	105	0 ac	0 ac	250	250	82	-	-	-
V601	6N030	NC	0 ac	6.3 ac	NC	33 ac	NC	33 ac	NC	-	-
V602	5651	NC	NC	NC	NC	85	NC	0	-	-	-
V603	12AX7	200	125	125.	0 ac	0 ac	125	58	58	6.3 ac	-
V604	6AS7G	200	380	250	200	380	250	6.3 ac	0 ac	-	-
V605	5U4G	NC	36 ac	NC	400 ac	NC	400 ac	NC	420	-	-
V606	OA3	NC	-75	NC	NC	0	NC	NC	NC	-	-
J601	Sweep	6.3 ac	0 ac	NC	115 ac	165	250	-75	0	0 ac	0 ac
J602	Marker	6.3 ac	0 ac	0	250	6.3	0	-	-	-	-
J603	Audio	0 ac	6.3 ac	250	0	-	-	-	-	-	-
J604	Panel	0 ac	64 ac	6.3 ac	64 ac	-	-	-	-	-	-
RF Term. Bd.		6.3 ac	0 ac	165	104	220	250	3.2	2.5	-1.4	-

Circuit Symbol	Value	Description	BRC Part No.
		PIP CHASSIS	
R-101	1.5KΩ	Res. Fixed ±5% 1W	80213
R-102	68KΩ	Res. Fixed ±5% 1/2W	80549
R-103	33KΩ	Res. Fixed ±5% 1W	80488
R-104	10KΩ	Res. Fixed ±5% 2W	80334
R-105	2.2KΩ	Res. Fixed ±5% 1W	80212
R-106	33KΩ	Res. Fixed ±5% 1/2W	80461
R-107	1 MegΩ	Res. Var. ±20% 1/2W	A81125
R-108	2.2KΩ	Res. Fixed ±5% 1/2W	80256
R-109	2.2KΩ	Res. Fixed ±5% 1/2W	80256
R-110	68KΩ	Res. Fixed ±5% 1/2W	80549
R-111	33KΩ	Res. Fixed ±5% 1W	80488
R-112	10KΩ	Res. Fixed ±5% 2W	80334
R-113	47KΩ	Res. Fixed ±5% 1/2W	80460
R-114	15KΩ	Res. Fixed ±5% 2W	80338
R-115	33KΩ	Res. Fixed ±5% 1/2W	80461
R-116	10KΩ	Res. Fixed ±5% 1/2W	80361
R-117	50KΩ	Res. Var. ±20% 1/2W	A 81126
R-118	2.2KΩ	Res. Fixed ±5% 1/2W	80256
R-119	1 MegΩ	Res. Var. ±20% 1/2W	A81125
R-120	470KΩ	Res. Fixed ±5% 1/2W	80640
R-121	2.2KΩ	Res. Fixed ±5% 1/2W	80256
R-122	2.2KΩ	Res. Fixed ±5% 1/2W	80256
C-101	10-10-10	Cap. Fixed 450V	83050
C-102	24μμf	Cap. Fixed ±2% 500V	82100
C-103	24μμf	Cap. Fixed ±2% 500V	82100
C-104	.033μf	Cap. Fixed -- 400V	82431
C-105	22μμf	Cap. fixed ±2-1/2% 600V	82028
C-106	22μμf	Cap. Fixed ±2-1/2% 600V	82028
C-107	24μμf	Cap. Fixed ±2% 500V	82100
C-108	24μμf	Cap. Fixed ±2% 500V	82100
C-109	.033μf	Cap. Fixed -- 400V	82431
C-110	68μμf	Cap. Fixed ±5% 500V	82134
C-111	.25μf	Cap. Fixed -15 + 25% 400V	83033
V-101		Tube	12AU7
V-102		Tube	12AU7
V-103		Tube	12AU7
X-101		Crystal IN34	91018
X-102		Crystal IN34	91018
X-103		Crystal IN34	91018
X-104		Crystal IN34	91018

BIRDIE CHASSIS

Circuit Symbol	Value	Description	BRC Part No.
R-201	4.7KΩ	Res. Fixed ±5% 1/2W	80304
R-202	470Ω	Res. Fixed ±5% 1/2W	80170
R-203	22KΩ	Res. Fixed ±5% 1/2W	80472
R-204	22KΩ	Res. Fixed ±5% 1/2W	80472
R-205	2.2KΩ	Res. Fixed ±10% 2W	80277
R-206	10KΩ	Res. Fixed ±10% 1/2W	80361
R-207	100Ω	Res. Var. ±20% 1/2W	A81124
R-208	4.7KΩ	Res. Fixed ±5% 1/2W	80304
R-209	10KΩ	Res. Fixed ±5% 1/2W	80361
R-210	10KΩ	Res. Fixed ±5% 1/2W	80361
R-211	3.3KΩ	Res. Fixed ±5% 1/2W	80253
R-212	68KΩ	Res. Fixed ±5% 1/2W	80549
R-213	100KΩ	Res. Fixed ±5% 1/2W	80517
R-214	1KΩ	Res. Fixed ±5% 1/2W	80148
R-215	100KΩ	Res. Fixed ±5% 1/2W	80517
R-216	33KΩ	Res. Fixed ±5% 1/2W	80461
R-217	1KΩ	Res. Fixed ±5% 1W	80150
R-218	1KΩ	Res. Fixed ±5% 1/2W	80148
R-219	220KΩ	Res. Fixed ±5% 1/2W	80555
R-220	10KΩ	Res. Fixed ±5% 1/2W	80361
R-221	10KΩ	Res. Fixed ±5% 1/2W	80361
R-222	10KΩ	Res. Fixed ±5% 1/2W	80361
R-223	220Ω	Res. Fixed ±5% 1/2W	80188
R-224	47Ω	Res. Fixed ±5% 1/2W	80041
R-225	100KΩ	Res. Fixed ±5% 1/2W	80517
R-226	4.7KΩ	Res. Fixed ±5% 1/2W	80304
R-227	68KΩ	Res. Fixed ±5% 1/2W	80549
R-228	33KΩ	Res. Fixed ±5% 1/2W	80461
R-229	22KΩ	Res. Fixed ±5% 1/2W	80472
R-230	220KΩ	Res. Fixed ±5% 1/2W	80555
R-231	10KΩ	Res. Fixed ±5% 1/2W	80361
R-232	33KΩ	Res. Fixed ±5% 1/2W	80461
R-233	68KΩ	Res. Fixed ±5% 1/2W	80549
R-234	1 MegΩ	Res. Var. ±20% 1/2W	A81511
R-235	10KΩ	Res. Fixed ±10% 10W	80343
R-236	25KΩ	Res. Fixed ±10% 5W	80410
R-237	51KΩ	Res. Fixed ±5% 1W	80440
R-238	2.2KΩ	Res. Fixed ±5% 1/2W	80256
R-239	470KΩ	Res. Fixed ±5% 1/2W	80640
R-240	68KΩ	Res. Fixed ±5% 1/2W	80549
R-241	1.5KΩ	Res. Fixed ±5% 1/2W	80273
R-242	1KΩ	Res. Fixed ±5% 1/2W	80148
C-201	20-20μf	Cap. Fixed 450V	83051
C-202	47μμf	Cap. Fixed ±2-1/2% 600V	82115
C-203	33μμf	Cap. Fixed ±2-1/2% 600W	82114
C-204	33μμf	Cap. Fixed ±2-1/2% 600W	82114
C-205	22μμf	Cap. Fixed ±2-1/2% 600W	82028

BIRDIE CHASSIS (continued)

Circuit Symbol	Value	Description	BRC Part No.
C-206	0.25μf	Cap. Fixed -15 + 25% 400V	83033
C-207	33μμf	Cap. Fixed ±2-1/2% 600V	82114
C-208	240μμf	Cap. Fixed ±5% 500V	82228
C-209	15μμf	Cap. Fixed ±2%	82023
C-210	3300μμf	Cap. Fixed ±5% 500V	82323
C-211	1-12μμf	Cap. Var. Tubular Glass	84090
C-212	0.01μf	Cap. Fixed 600V	82428
C-213	0.01μf	Cap. Fixed 600V	82428
C-214	0.01μf	Cap. Fixed 600V	82428
C-215	240μμf	Cap. Fixed ±5% 500V	82228
C-216	0.1μf	Cap. Fixed -20 + 30% 400V	83038
C-217	150μμf	Cap. Fixed ±5% 500V	82202
C-218	50μμf	Cap. Fixed ±5% 500V	82149
C-219	50μμf	Cap. Fixed ±5% 500V	82149
C-220	50μμf	Cap. Fixed ±5% 500V	82149
C-221	150μμf	Cap. Fixed ±5% 500V	82202
C-222	240μμf	Cap. Fixed ±5% 500V	82228
C-223	240μμf	Cap. Fixed ±5% 500V	82228
C-224	0.25μf	Cap. Fixed -15 + 25% 400V	83033
C-225	.3-3.μμf	Cap. Var. Tubular Glass	84088
C-226	33μμf	Cap. Fixed ±2-1/2% NPO	82114
C-227	33μμf	Cap. Fixed ±2-1/2% N 080	82124
C-228	200μμf	Cap. Fixed ±5% 500V	82209
C-229	18μμf	Cap. Fixed ±0.5μμf 600V	82126
C-231	240μμf	Cap. Fixed ±5% 500V	82228
C-232	100μμf	Cap. Fixed ±5% 500V	82122
C-233	100μμf	Cap. Fixed ±5% 500V	82122
C-234	1000μμf	Cap. Fixed ±5% 500V	82311
C-235	0.5μf	Cap. Fixed -15 + 25% 400V	83030
C-236	240μμf	Cap. Fixed ±5% 500V	82228
C-237	50μμf	Cap. Fixed ±2-1/2% 600V	82110
C-238	50μμf	Cap. Fixed ±2-1/2% 600V	82110
C-239	1.0μf	Cap. Fixed ±2-1/2% 400V	83065
C-240	0.01μf	Cap. Fixed ±2-1/2% 600V	82428
C-241	0.01μf	Cap. Fixed ±2-1/2% 600V	82428
V-201		Tube	6AU6
V-202		Tube	6AK5
V-203		Tube	12AX7
V-204		Tube	12AU7
V-205		Tube	6U8
L-201	10MC	Choke Assembly	A303149
L-202	2.5MC	Choke Assembly	A303148
L-203	0.5MC	Choke Assembly	A303147
L-204	0.5MC	Choke Assembly	A303160
L-205	0.5MC	Choke Assembly	A303159
L-206	100μh	Choke Assembly	A85601

Circuit Symbol	Value	Description	BRC Part No.
		BIRDIE CHASSIS (continued)	
L-207	0.1MC	Choke Assembly	A303156
L-208	0.5MC	Choke Assembly	A303157
L-209	0.5MC	Choke Assembly	A303158
L-210A	0.1MC	Choke Assembly	A303289
L-210B	0.1MC	Choke Assembly	A303289
X-201	2.5MC	Crystal	A91080
S-201		Switch, Marker Selector	A303166
J-201		Jack, UG-291/U	A89065
J-202		Jack Open Circuit	A89038
J-203		Connector, Receptacle UG-290/U	302353
P-201		BNC Plug, UG-260/U	303216
P-202		Plug, Jones 6 Prong	301749
		AUDIO OSCILLATOR	
R-301	25KΩ	Res. Fixed ±10% 5W	80410
R-302	68KΩ	Res. Fixed ± 5% 1W	80552
R-303	6.8KΩ	Res. Fixed ± 5% 2W	80321
R-304	1KΩ	Res. Var. ±20% 1/2W	A81105
R-305	220KΩ	Res. Fixed ± 5% 1/2W	80555
R-306	156KΩ	Res. Fixed ± 1% 1/2W	80566
R-307	5KΩ	Res. Var. ±20% 1/2W	A81325
R-308	470Ω	Res. Fixed ± 5% 1W	80124
R-309	156KΩ	Res. Fixed ± 1% 1/2W	80566
C-301	8μf	Cap. Fixed 450V	83029
C-302	0.1μf	Cap. Fixed ±10% 400V	83001
C-303	8μf	Cap. Fixed 450V	83029
C-304	1000μμf	Cap. Fixed ±2% 500V	82302
C-305	1000μμf	Cap. Fixed ±2% 500V	82302
V-301		Tube	12AU7
S-301		Switch, AM	A303207
I-301		Lamp	90907
P-301		Plug, Jones 4 Prong	301756

RF UNIT

Circuit Symbol	Value	Description	BRC Part No.
R-401 thru R-421		Step Attenuator	A302989
R-422	10Ω	Res. Fixed ± 5% 1/2W	80006
R-423	10Ω	Res. Fixed ± 5% 1/2W	80006
R-424	10Ω	Res. Fixed ± 5% 1/2W	80006
R-425	10Ω	Res. Fixed ± 5% 1/2W	80006
R-426	100Ω	Res. Fixed ± 5% 1/2W	80062
R-427	22KΩ	Res. Fixed ± 5% 1/2W	80472
R-428	22KΩ	Res. Fixed ± 5% 1/2W	80472
R-429	100Ω	Res. Fixed ± 1% 1/4W	80053
R-430	220Ω	Res. Fixed ± 5% 1/2W	80188
R-431A	175Ω	Res. Var. -- --	81026
R-431B	1KΩ	Res. Var. -- --	81027
R-432	33Ω	Res. Fixed ± 5% 1/2W	80032
R-433	470Ω	Res. Fixed ± 5% 1/2W	80170
R-434	330Ω	Res. Fixed ± 5% 1W	80131
R-435	10KΩ	Res. Fixed ± 5% 1W	80331
R-436	3.3KΩ	Res. Fixed ± 5% 2W	80236
R-437	330Ω	Res. Fixed ± 5% 1W	80131
R-438	10KΩ	Res. Fixed ± 5% 1W	80331
R-439	3.3KΩ	Res. Fixed ± 5% 2W	80236
R-440	680Ω	Res. Fixed ± 5% 1/2W	80138
R-441	330Ω	Res. Fixed ± 5% 1W	80131
R-442	100KΩ	Res. Fixed ± 5% 1/2W	80517
R-443	10KΩ	Res. Fixed ± 5% 1W	80331
R-444	3.3KΩ	Res. Fixed ± 5% 2W	80236
R-445	5KΩ	Res. Var. ±20%	A81311
R-446	26KΩ	Res. Fixed ±2 1/2% 1/2W	80411
R-447	3.3KΩ	Res. Fixed ± 5% 1/2W	80253
C-401A	5-45μμf	Cap. Var.	303215
C-401B			
C-402	0.-0.7μμf	Cap. Trimmer Vane	A303345
C-403	22μμf	Cap. Fixed ±1/2% 600V	82028
C-404	22μμf	Cap. Fixed ±1/2% 600V	82028
C-405	470μμf	Cap. Fixed ± 5% 500V	82229
C-406	.01μf	Cap. Fixed 600V	82428
C-407	.01μf	Cap. Fixed 600V	82428
C-408	250μμf	Cap. Fixed ±10%	82232
C-409	250μμf	Cap. Fixed ±10%	82232
C-410	250μμf	Cap. Fixed ±10%	82232
C-411	.01μf	Cap. Fixed 600V	82428
C-412 thru C-438	250μμf	Cap. Fixed ±10%	82232
C-439	.01μf	Cap. Fixed 600V	82428
C-440			
C-441	2μf	Cap. Fixed -20+30% 200V	83055
C-442	2μf	Cap. Fixed -20+30% 200V	83055
V-401		Tube	6BK7A
V-402		Tube	5718

Circuit Symbol	Value	Description	BRC Part No.
		RF UNIT (continued)	
V-403		Tube	5718
M-401		Meter	A303214
F-401	1/8 Amp.	Fuse Slo Blo	93697
L-401A		Choke Ass'y	A303090
L-401B		Choke Ass'y	
L-402A		Choke Ass'y	A303091
L-402B		Choke Ass'y	
L-403A		Choke Ass'y	A303092
L-403B		Choke Ass'y	
L-404A		Choke Ass'y	A303093
L-404B		Choke Ass'y	
L-405A		Choke Ass'y	A303094
L-405B		Choke Ass'y	
L-406	250μh	Choke	A303146
L-407	250μh	Choke	A303146
L-408		Yoke Ass'y	A302866
L-409		Yoke Ass'y	A302866
L-410 thru L-416	50μh	Coil R.F. ± 5%	A85592
L-417	18μh	Coil R.F.	A303226
L-418		Coil R.F.	A303226
L-419 thru L-425	50μh	Coil R.F. ± 5%	A85592
L-426	18μh	Coil R.F.	A303226
L-427		Coil R.F.	A303226
X-401		Crystal T6	91007
X-402		Crystal IN34A	91081
X-403		Crystal IN34A	91081
X-404		Crystal T6	91007
S-401		Switch, Rotary	A303084
S-402		Band Switch, 240-A	B302990
J-401		Jack UG-291/U	89065
J-402		Jack UG-291/U	89065
J-403		Jack UG-291/U	89065
J-404		Jack, Part of Attenuator	Part of A302989
P-401		Plug, UG-88/U	94156
P-402		Plug, UG-88/U	94156

SWEEP CHASSIS

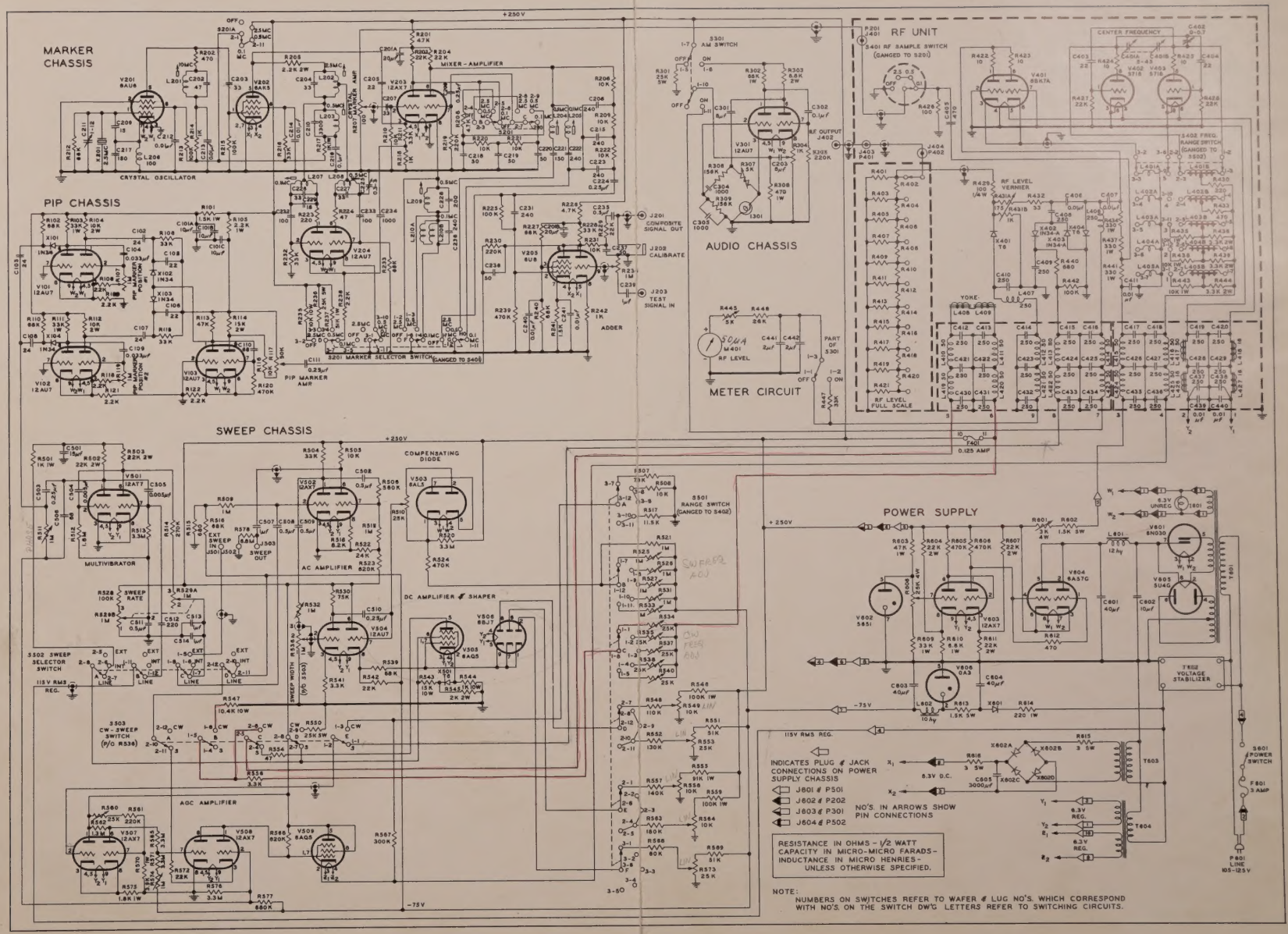
Circuit Symbol	Value	Description	BRC Part No.
R-501	1KΩ	Res. Fixed ± 5% 1W	80150
R-502	22KΩ	Res. Fixed ± 5% 2W	80481
R-503	22KΩ	Res. Fixed ± 5% 2W	80481
R-504	33KΩ	Res. Fixed ± 5% 1/2W	80461
R-505	10KΩ	Res. Fixed ± 5% 1/2W	80361
R-506	.56MegΩ	Res. Fixed ± 5% 1/2W	80629
R-507	7.8K	Res. Fixed ± 1% 1/2W	80576
R-508	10K	Res. Fixed ± 1% 1/2W	80578
R-509	1MegΩ	Res. Fixed ± 5% 1/2W	80621
R-510	25KΩ	Res. Var. ±20% C1	81420
R-511	1MegΩ	Res. Var. ±20% C1	81513
R-512	1.8MegΩ	Res. Fixed ± 5% 1/2W	80648
R-513	3.3MegΩ	Res. Fixed ± 5% 1/2W	80644
R-514	270KΩ	Res. Fixed ± 5% 1/2W	80604
R-515	680Ω	Res. Fixed ± 5% 1/2W	80138
R-516	68KΩ	Res. Fixed ± 5% 1/2W	80549
R-517	11.5KΩ	Res. Fixed ± 1% 1/2W	80577
R-518	8.2KΩ	Res. Fixed ± 5% 1/2W	80326
R-519	1MegΩ	Res. Fixed ± 5% 1/2W	80621
R-520	3.3MegΩ	Res. Fixed ± 5% 1/2W	80644
R-521	1MegΩ	Res. Fixed ± 5% 1/2W	80621
R-522	24KΩ	Res. Fixed ± 5% 1/2W	80407
R-523	0.62MegΩ	Res. Fixed ± 5% 1/2W	80618
R-524	470KΩ	Res. Fixed ± 5% 1/2W	80640
R-525	1MegΩ	Res. Var. ±20% C1	81513
R-526	1MegΩ	Res. Var. ±20% C1	81513
R-527	1MegΩ	Res. Var. ±20% C1	81513
R-528	100KΩ	Res. Fixed ± 5% 1/2W	80517
R-529	1Meg-1Meg	Res. Var., Dual	A81512
R-530	75KΩ	Res. Fixed ± 5% 1/2W	80508
R-531	1MegΩ	Res. Var. ±20% C1	81513
R-532	1MegΩ	Res. Var. ±20% C1	81513
R-533	1MegΩ	Res. Var. ±20% C1	81513
R-534	25KΩ	Res. Var. ±20% C1	81420
R-535	25KΩ	Res. Var. ±20% C1	81420
R-536	1MegΩ	Res. Var. ±20% C1 P/O S-503	81514
R-537	25KΩ	Res. Var. ±20% C1	81420
R-538	25KΩ	Res. Var. ±20% C1	81420
R-539	68KΩ	Res. Fixed ± 5% 1/2W	80549
R-540	25KΩ	Res. Var. ±20% C1	81420
R-541	3.3KΩ	Res. Fixed ± 5% 1/2W	80253
R-542	22KΩ	Res. Fixed ± 5% 1/2W	80472
R-543	15KΩ	Res. Fixed ± 5% 10W	80396
R-544	1KΩ	Res. Fixed ± 5% 10W	80199
R-545	2KΩ	Res. Fixed ± 5% 2W	80215
R-546	100KΩ	Res. Fixed ± 5% 1W	80521
R-547	10.4KΩ	Res. Fixed ± 5% 10W	80395
R-548	110 KΩ	Res. Fixed ± 1% 1/2W	80570

SWEEP CHASSIS (continued)

Circuit Symbol	Value	Description	BRC Part No.
R-549	10KΩ	Res. Var. ±20% C1	81337
R-550	25KΩ	Res. Fixed ±10% 5W	80410
R-551	51KΩ	Res. Fixed ± 5% 1/2W	80502
R-552	130KΩ	Res. Fixed ± 1% 1/2W	80571
R-553	25KΩ	Res. Var. ±20% C1	81420
R-554	47Ω	Res. Fixed ± 5% 1/2W	80041
R-555	91KΩ	Res. Fixed ± 5% 1W	80514
R-556	3.3KΩ	Res. Fixed ± 5% 1/2W	80253
R-557	140KΩ	Res. Fixed ± 1% 1/2W	80572
R-558	10KΩ	Res. Var. ±20% C1	81337
R-559	100KΩ	Res. Fixed ± 5% 1W	80521
R-560	25KΩ	Res. Var. ±20% C1	81420
R-561	220KΩ	Res. Fixed ± 5% 1/2W	80555
R-562	1.3MegΩ	Res. Fixed ± 5% 1/2W	80680
R-563	180KΩ	Res. Fixed ± 1% 1/2W	80573
R-564	10KΩ	Res. Var. ±20% C1	81337
R-565	3.3MegΩ	Res. Fixed ± 5% 1/2W	80644
R-566	0.62MegΩ	Res. Fixed ± 5% 1/2W	80618
R-567	300KΩ	Res. Fixed ± 1% 1/2W	80614
R-568	60KΩ	Res. Fixed ± 1% 1/2W	80574
R-569	51KΩ	Res. Fixed ± 5% 1/2W	80502
R-570	3.9KΩ	Res. Fixed ± 5% 1W	80241
R-571	3.3MegΩ	Res. Fixed ± 5% 1/2W	80644
R-572	22KΩ	Res. Fixed ± 5% 1/2W	80472
R-573	25KΩ	Res. Var. ±20% C1	81420
R-574	1MegΩ	Res. Var. ±20% C1	81513
R-575	1.8KΩ	Res. Fixed ± 5% 1W	80254
R-576	3.3MegΩ	Res. Fixed ± 5% 1/2W	80644
R-577	680KΩ	Res. Fixed ± 5% 1/2W	80663
R-578	6.8MegΩ	Res. Fixed ± 5% 1/2W	80642
C-501	15μf	Cap. Fixed 450V	83046
C-502	5μf	Cap. Fixed -15+25% 400V	83030
C-503	25μf	Cap. Fixed -15+25% 400V	83033
C-504	.005μf	Cap. Fixed ± 2%	82325
C-505	.005μf	Cap. Fixed ± 2%	82325
C-506	68μμf	Cap. Fixed ±20% 500V	82117
C-507	1.0μf	Cap. Fixed 400V	83065
C-508	.5μf	Cap. Fixed -15+25% 400V	83030
C-509	.5μf	Cap. Fixed -15+25% 400V	83030
C-510	.25μf	Cap. Fixed -15+25% 400V	83033
C-511	.5μf	Cap. Fixed -15+25% 400V	83030
C-512	220μμf	Cap. Fixed ±10%	82212
C-513	1μf	Cap. Fixed +20-10% 600V	82324
C-514	1μf	Cap. Fixed +20-10% 600V	82324
V-501		Tube	12AT7
V-502		Tube	12AX7

Circuit Symbol	Value	Description	BRC Part No.
		SWEEP CHASSIS (continued)	
V-503		Tube	6AL5
V-504		Tube	12AU7
V-505		Tube	6AQ5
V-506		Tube	6BJ7
V-507		Tube	12AX7
V-508		Tube	12AX7
V-509		Tube	6AQ5
S-501		Switch, Range	A300200
S-502		Switch, Sweep Selector	A303206
S-503		Switch, CW Sweep P/O R-536	A81514
X-501		Crystal T6	91007
J-501		Binding Post	A90042
J-502		Binding Post	A90042
J-503		Binding Post	A90042
P-501		Plug, Jones 10 Prong	303335
P-502		Plug, Jones 4 Prong	301756
		POWER SUPPLY	
R-601	3KΩ	Res. Var. ±10% 4W	A81024
R-602	1.5KΩ	Res. Fixed ± 5% 5W	80214
R-603	47KΩ	Res. Fixed ± 5% 1W	80470
R-604	22KΩ	Res. Fixed ± 5% 2W	80481
R-605	470KΩ	Res. Fixed ± 5% 1/2W	80640
R-606	470KΩ	Res. Fixed ± 5% 1/2W	80640
R-607	22KΩ	Res. Fixed ± 5% 2W	80481
R-608	25KΩ	Res. Var. ±10% 4W	81025
R-609	33KΩ	Res. Fixed ± 5% 1W	80488
R-610	6.8KΩ	Res. Fixed ± 5% 1W	80322
R-611	22KΩ	Res. Fixed ± 5% 2W	80481
R-612	470Ω	Res. Fixed ± 5% 1/2W	A80170
R-613	1.5KΩ	Res. Fixed ± 5% 5W	80214
R-614	220Ω	Res. Fixed ±10% 1W	A80190
R-615	3Ω	Res. Fixed ±10% 5W	80043
R-616	3Ω	Res. Fixed ±10% 5W	80043
C-601	40μf	Cap. Fixed 450V	83053
C-602	10μf	Cap. Fixed 450V	83040
C-603	40μf	Cap. Fixed 450V	83053
C-604	40μf	Cap. Fixed 450V	83053
C-605	3000μf	Cap. Fixed 10V	83095

Circuit Symbol	Value	Description	BRC Part No.
		POWER SUPPLY (continued)	
V-601		Tube, Delay	6N030
V-602		Tube, Reference	5651
V-603		Tube, Amplifier	12AX7
V-604		Tube, Series	6AS7G
V-605		Tube, Rectifier	5U4G
V-606		Tube, Voltage Reg.	OA3
S-601		Switch, Power	A88059
L-601	12hy	Choke 250MA 150Ω DC	A300220
L-602	10hy	Choke, Filter	A301769
X-601		Rectifier, Selenium 100MA DC	300316
X-602(A, B, C, D)		Rectifier, Selenium 100MA DC	A303313
T-601		Transformer, Power	A303279
T-602		Stabilizer, Voltage 50VA 60~	*A85028
T-603		Transformer, Filament	A303312
T-604		Transformer, Filament	A303280
I-601		Lamp	A90904
F-601		Fuse 3A	93252
J-601		Socket, 10 Prong	303283
J-602		Socket, 6 Prong	301754
J-603		Socket, 4 Prong	301755
J-604		Socket, 4 Prong	301755
P-601		Cord, Power	A01019
*		Stabilizer, Voltage 50 (Used in place of A85028, when needed)	A303330


MARKER CHASSIS
CRYSTAL OSCILLATOR
MIXER - AMPLIFIER
PIP CHASSIS
PIP MARKER AMP #1
PIP MARKER AMP #2
PIP MARKER AMP
3201 MARKER SELECTOR SWITCH GANGED TO S402
J201 COMPOSITE SIGNAL OUT
J202 CALIBRATE
J203 TEST SIGNAL IN
ADDER
AUDIO CHASSIS
3301 AM SWITCH
RF OUTPUT J402
RF UNIT
S401 RF SAMPLE SWITCH (GANGED TO S201)
CENTER FREQUENCY
S402 FREQ. RANGE SWITCH (GANGED TO S501)
RF LEVEL VERNIER
YOKE
METER CIRCUIT
RF LEVEL
RF LEVEL FULL SCALE
SWEEP CHASSIS
MULTIVIBRATOR
AC AMPLIFIER
DC AMPLIFIER & SHAPER
AGC AMPLIFIER
3502 SWEEP SELECTOR SWITCH
3503 CW - SWEEP SWITCH (P/O R536)
3501 RANGE SWITCH (GANGED TO S402)
POWER SUPPLY
VOLTAGE STABILIZER
INDICATES PLUG & JACK CONNECTIONS ON POWER SUPPLY CHASSIS
J601 & P501
J602 & P202
J603 & P301
J604 & P502
NO'S. IN ARROWS SHOW PIN CONNECTIONS
RESISTANCE IN OHMS - 1/2 WATT
CAPACITY IN MICRO-MICRO FARADS - INDUCTANCE IN MICRO HENRIES - UNLESS OTHERWISE SPECIFIED.
NOTE:
NUMBERS ON SWITCHES REFER TO WAFER & LUG NO'S. WHICH CORRESPOND WITH NO'S. ON THE SWITCH DW'G LETTERS REFER TO SWITCHING CIRCUITS.

www.manualsplus.com
1002275